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THE WORRISOME FUEL QUESTION.

What is the average small central station going to show on its balance sheet if the price of fuel keeps on the rise? To be sure, at the present time it is the amateur stoker who runs his hot-air furnace that is worrying over the coal situation, but as anthracite goes up so does every other kind of fuel, and an inspection of the coal prices for the past few years is not a pleasant matter for any class of consumers. There is a bad time coming, if one may judge from the signs of the situation now visible; and although the coal supply is very far from showing signs of impending exhaustion in our own day, it makes little difference to the unhappy consumer whether prices go up from one cause or from another. In this exigency it is well to stop and consider the gas-engine situation far more seriously than ever before. It is a well-known fact that abroad "producer" and other gas has shown itself able to give very cheap power indeed even against rather cheap coal. Gas can be economically obtained from fuel that is not over well adapted for direct use, and at all events for power purposes it can be put in the holders at a surprisingly low price. The gas engine is best known at present in very small sizes, which give a very incomplete idea of its economical possibilities. With a fair grade of gas in the holder, at 20 cents or so per thousand feet, a big gas engine can turn off power at a figure that demands very respectful consideration indeed. Of course, if all fuel keeps on rising in price, gas itself must become somewhat dearer, but the more the grades of fuel that can be economically used for power purposes, the more the general situation is likely to be relieved; for not only is the demand for particular grades lessened, but it is rendered far more difficult to corner the market to any considerable extent. Coal in general is very widely distributed, even if some special coal in particular, to wit, anthracite, is scarce.

STATISTICS OF THE INDUSTRY.

Elsewhere in the pages of this issue will be found an abstract of the report published by the U. S. Census Office, on the manufacture of electrical apparatus and supplies during the census year, 1900. In view of the fact that the report is the first attempt in this direction, and had been preceded in other censuses by sporadic efforts, the difficulty of the task is obvious; but a study of the report, occupying some 54 pages, shows that the census authorities were very successful not only in eliciting the data in bulk but in securing detail in large variety. In 1880 and 1890 the figures of electrical manufacturing were loosely collated, without any attempt to give precision beyond the round totals; but it was recognized that the growth in the art during the past ten years called for a more respectful and elaborate treatment. Aside from inquiries into electrical manufacturing, the Census Office has hitherto attempted little in the electrical field. A cursory investigation was made of telephony in 1880, and ten years later there was an interesting study of street railways, as well as a report on electric lighting in the State of New York; but for telegraphy, we have had of late years to look wholly to the Western Union management for data of any value. The permanent census office, constituted recently by Congress, is fortunately now in shape to prosecute inquiries into all these fields of "public supply" that concern social welfare so deeply; and in the meantime an excellent start has now been made in regard to the manufacturing industry that has to furnish the apparatus required in the local plants or for general consumption.

As will be noted from the returns, 580 establishments, with a capital of $83,130,943, some 5,000 officials and 40,890 wage-earners, produced

apparatus and supplies in the census year, valued at $91,348,889. There were, however, reports considered from 132 other establishments making apparatus of an electrical character as part of their business, and, all told, these 712 concerns turned out product to the value of $104,738,719. Nor was this in reality the limit, for it is pointed out in the report that many companies, within and outside the electrical field, build a great deal of their own apparatus for themselves, but not for sale. No account, moreover, is taken of electric launches, automobiles or locomotives, these being accounted for in the respective branches of ship building, carriage building and locomotive building; while they would obviously include and duplicate some apparatus already reported otherwise by electrical manufacturers. There is also no inclusion of any electrochemical or electrometallurgical products, although well nigh all our copper is refined electrically, and all our aluminum, carborundum, calcium carbide, etc., is the product of electricity. However, these exclusions are evidently directed by an intelligent policy, which at once strengthens confidence in the work of the Census Office as a whole, and illustrates the care with which the general plan was laid out at the beginning. It is to be added that the figures given are those derived directly from the manufacturers themselves; have been carefully sifted, and, therefore, involve a minimum possibility of error. It would, indeed, hardly be feasible to get nearer the truth, for no one else possesses the mechanism and authority of the government for prosecuting such an inquiry or for punishing misstatements made in the returns. As a matter of fact, throughout the expert work on the Twelfth Census, the manufacturers in all lines of industry have in general done all they could to render assistance.

The activity revealed by this report in electrical production has certainly not fallen off in the last two years, but has been maintained and intensified. An average increase of 20 per cent. each year would bring the total output for 1902 up to about $150,000,000; and there is no reason for doubting the approximate validity of that figure. The largest concerns have enjoyed a bigger growth even than that, in many instances, and the area to be supplied is ever increasing both at home and abroad. The American people in the census year, it is stated in the report, were spending at least as much on electricity as on daily bread, and it would not be easy to find any one fact more typical of the temperament and progressiveness of the nation.

While electrical manufacturing is shown to be chiefly concentrated in some six eastern and two middle or western States, the industry is fairly widespread, its data being furnished by no fewer than 19 States. It is a little surprising to see Pennsylvania head the list of States, with a total of nearly twenty-one millions, but New York had nearly eighteen millions, and Illinois nearly twelve. It is hard to tell just what conditions determine locality for the plants, but three causes at least are influential, viz., nearness of steel and iron; cheapness of lumber, and abundance of skilled labor. One point which emerges is the tremendous increase in the production of electric motors and their use in general manufacturing. But, after all, such motors are still only 4 per cent. of the power employed in the manufacturing industries of the country. It had seemed to reach a good deal more than that, but there are many outlets for motors; and in reality the figure is full of encouragement, for it shows how infinite is the work that lies ahead for electricity in one direction alone. Indeed, but a single field is seen from this report to be relatively restricted or narrowing, namely, the telegraph; but we refuse to believe that it is any less lacking to-day in opportunities of growth and improvement than it ever was.

Private Plants.

The electrical supply companies in most large cities have in the last few years adopted the wise policy of keeping prices down to a basis that renders isolated lighting plants far less attractive economically than they have been in the past. In a surprisingly large number of cases, the investigation of the possibilities of isolated plants in large buildings shows that supply from public plants is either actually cheaper or so near to the same cost as to make investment in a private plant inadvisable. Yet in spite of this there is a large field for private lighting plants, especially in places which have no public supply. Residence lighting, while becoming more and more common in this country, has not yet been exploited with anything like the thoroughness that it deserves—and this is the day of large country seats and summer homes. The advent of automobiles, if it had done nothing else, would mark an epoch in the construction of light and easily-operated prime movers of types well adapted for domestic use. Along this line there ought to be great progress in small isolated electric plants, and while something has been done already, the business has not yet been exploited to anything like the proper extent. In the present state of the art, it should be possible to make a 2 or 3-hp direct-connected oil engine and dynamo that would be pretty nearly fool-proof, and that would require hardly any attention. Such a plant with or even without a storage battery forms a very beautiful and economical means of lighting country houses. It is a fact that from such a plant properly handled one can get more and better light per gallon of oil than by its direct combustion—to say nothing of the other advantages. In spite of the number of small isolated plants now in operation, there has been little done in the production of generating sets specially designed for such work, and it is certainly a branch of the art that deserves encouragement. In some of the coming expositions it would be worth the while to make a separate class for such combination plants and to give them thus such a standing by themselves as they deserve.

The Coming of the Turbine.

We are watching and noting with the keenest interest the performance of the steam turbine plants installed in increasing numbers. Thus far the reports received have been of a highly encouraging character, but lacking in that detail which is necessary for reaching final conclusions. While the tests as a rule show a degree of economy fully up to the standard of the compound-condensing engine, few installations have been in operation long enough to show what difficulties, if any, will crop out after extended trial. So far as electrical uses go, the turbine has the advantage of high rotative speed, thus giving to the dynamo relatively low cost and high efficiency, since speed is certainly the cheapest way of getting electromotive force. A test based on steam per kw-hour at the bus-bars shows the turbine in a particularly favorable light, and whatever its place in general manufacturing may prove to be, it has a strong claim for favor in electrical power stations. Some of the economic results reported are of a most startling character for machines of moderate capacity. Much of the future of the turbine, however, depends on its performance in rather small and in very large sizes, and here the data are as yet rather incomplete. What, for instance, can be expected from a 10-kw turbo-generator and from a 2,500-kw one in fair comparison with the best reciprocating engines of similar capacity? As to the former case, the turbine ought by good rights to have a material advantage, since small engines, even the best of them, are notoriously uneconomical; but the latter condition is less to the turbine's advantage. And since the work of the future will include plants of truly gigantic dimensions, the performance of big turbines is of the greatest importance. It may be that in turbine practice the effect of linear dimensions upon economy may show some interesting peculiarities. Just at the present time the public are rather in the dark about turbine performances, as they are going through the stage of exploitation which is conducive to secretiveness—a policy often necessarily adopted by the manufacture., but a bit vexatious to the would-be buyer.

A. I. E. E. PRIZES.

Elsewhere we make note of the award by the British Institution of Electrical Engineers of no less than twelve annual premiums for papers, aggregating in money value $500, and also two annual scholarships of $250 each. Of the premiums, eleven were provided from the funds of the institution, the remaining one being the Fahie premium of $50, offered annually. One scholarship is endowed by Sir David Salomons, and the other is a legacy from the late distinguished Anglo-American, Prof. David Hughes, the capital fund in each case being about $10,000. It is perhaps unnecessary to add that the American Institute of Electrical Engineers has thus far made no provision from its funds for premiums, nor received any endowments to be applied to the encouragement of the science and the art for which it stands. To supply this lack would indeed be a gracious act on the part of friends of the Institute, thereby relieving that body of its present invidious status with respect to many other professional bodies—though this is a minor consideration in view of the intrinsic and continuing benefit the application of such funds would have through coming ages.

Granting the desirability of prizes and anticipating their foundation, it may not be inappropriate to refer now to several questions apt to arise in matters of detail connected therewith. Two of these are with respect to the relative merits of money and medal prizes, and the frequency of award of a prize instituted for a given subject. In all but exceptional cases we believe in this country a medal would be more highly appreciated, as it would constitute a permanent and tangible record and possession, and being divorced from direct association with lucre would in the end be apt to be of more material benefit to the recipient. As to the frequency of awards, there is no doubt that a prize conferred annually in connection with a subject which does not permit of great progress during that period—and very few subjects do—is greatly cheapened, as has been demonstrated in more than one instance. Which tends also to reflect upon the awarding body. A prize conferred once in, say, five years, would undoubtedly represent very much more to the public and thus be of greater value to the recipient. A practical advantage is the smaller endowment for such a foundation, which in the case of a medal containing $100 in gold and including provision for striking, inscription and case, and the making of the die, would, we find, not be over $1,000, neglecting any cost there may be for a design.

Another question concerns the relative benefit of students' scholarships and endowments for research. It can be said in favor of the latter that any expenditure will be for a definite end, and the recipient will likely always be one who has developed special aptitude for research. In the case of a scholarship on the other hand, the precocity that singles a student from among his fellows may not be realized at maturity; and even if it should be, the subsequent career would not necessarily be one involving special benefit to the world at large. Taking the figure of the English scholarships, namely, $10,000, this amount should produce during, say, five years, about $1,500. While this sum is not large, yet expended on one object something might be accomplished of value, whereas if doled out in driblets little could be expected. Another consideration is that the award of the fund only once in five years would go far toward insuring that the object selected would be a creditable one. Finally, there is little doubt that after the first medal and first research fund had been established others would be provided for; and if each were devoted to a specific purpose, there might in time be annual awards by the Institute, but with a probability in that case of much more fruitful results than if numerous small awards were made each year. With such great names as Morse, Bell and Edison for commemoration—as well as others—and with a laudable desire on the part of many to connect their names indelibly with the profession which they cherish, the endowment of Institute prizes offers a dignified means to worthy objects.

ELECTRIC HEATING.

If our public-spirited Christian potentates, the coal barons, keep up their philanthropic endeavors, there will soon be an open question as to the economic possibilities of electric heating. With anthracite at its normal price the cost of current for sustained heating is practically prohibitive, however it may be with temporary work like cooking. But save in street cars, electric heating on a considerable scale has never been seriously tried. And street cars are particularly difficult spaces to heat, as they are in rapid motion through the cold air, have many rather draughty windows, and front and back doors generally ajar and constantly being opened and shut. In case of electric heating the energy employed is very inefficiently produced, save in case of water-power plants, but it is utilized without any of the incidental losses which are so severe in ordinary cases of domestic heating. The heat can be obtained when and where it is wanted, and can immediately be shut off when it is not wanted. In an ordinary house a very small number of rooms need to be actively heated all day and all night, provided one has the power of heating quickly a room in which heat is needed. This power is conferred in a remarkable degree by electric heaters, as is also the power of exact and prompt regulation.

We Americans are hardened sinners in the matter of overheated houses, and the customary furnace is not thought to be doing its duty unless it keeps the entire house at 75 degrees, or thereabouts, in the coldest weather. Perhaps the present coal prices will be a blessing in heavy disguise if they teach by experience the art of judicious and efficient heating. We are more than half inclined to think that wherever water-power plants are able to furnish energy at a low figure, electric radiators with a groundwork of steady heat from fuel will prove reasonably economical and convenient to a very unusual degree. Let us look at the matter a little in detail. With electric energy for heating purposes supplied at, say, 2 cents per kw-hour, except during the peak of the load, one can do pretty well at electric heating on a restricted scale save in very cold regions. Such spaces as bedrooms need active heat scarcely more than two or three hours per day, unless in case of sickness. Four or five kilowatt-hours per room would on an average be ample for such rooms, except on some very cold days, provided the exposure does not unduly chill the walls. Of other rooms only two or three require continuous heat through the day, and can be allowed to go without it during the night provided it can be applied promptly in the morning when it is needed. In spite of the cost of electrical energy one could, therefore, get in a moderate degree all the heat really needed without an unreasonable expenditure; and in case there should prove to be considerable demand for heating not a few hydraulic plants could afford to make very reasonable terms for power taken at other times than during the peak of the load. We should really like to see a careful trial made at some favorable point during the coming winter, to show what the economic possibilities of the process really are, and if coal holds up to its present prices we are inclined to think that electric heating will have a chance to make some material headway. It certainly can give high-priced coal a pretty hard rub for cooking, even at far higher prices than would rule if general heating began to come into vogue. A considerable portion of ordinary domestic heating apparatus in general is poorly designed for efficiency, for heretofore high efficiency has seemed needless, but with coal a half a cent a pound it is high time to look after waste. At such a figure it does not take long to burn up ten dollars, which at our hypothetical price would mean five hundred kilowatt-hours. The subject is certainly one which will repay careful investigation on the part of supply companies in favorable locations.

Opening Institute Meeting.

The first meeting of the American Institute of Electrical Engineers will be held at the Mechanical Engineers' Rooms, on Friday, Sept. 26, when Mr. B. G. Lamme, engineer of the Westinghouse Electric & Manufacturing Company, will read an important paper on "The Washington, Baltimore and Annapolis Single-Phase Railway." It will be remembered that note of this road was made in these pages some weeks ago. Mr. Lamme now proposes to enter into a detailed description of the system, which marks a new departure in electric railway work in America. It is also understood that Mr. C. F. Scott, who has recently returned from Europe, will make a presidential address.

International Mining Congress.

The International Mining Congress—hereafter to be known as the American Mining Congress—met at Butte, Mont, September 1-5, Mr. E. L. Shafner, of Cleveland, Ohio, presiding. The meeting was probably the largest and most important one ever held in the interest of mines and mining—at least in this country.

Strenuous efforts were made to assist the movement for a new governmental department of mines and mining, with a cabinet officer at its head. President Shafner urged it in his opening address, and addresses in favor of the project were made by several members. Resolutions were also adopted to the same effect. A bill, introduced in Congress last spring by Mr. Kearns, was discussed at length, and almost unanimously condemned. It limits the location of claims to one for each individual; also forbids mining along a vein when the vein runs farther than the surface location of the claim.

The meeting next year is to be held at Deadwood, S. Dak., in September, but at a date to be more accurately fixed hereafter.

The exhibition of mineral products of Montana and other states under the direction of Mr. J. R. Wharton, manager of the Electric street railway service, of Butte, and also of the Columbia Gardens, was an important feature of the congress. Besides Montana, Idaho, Oregon, Wyoming, Colorado and Kansas, as well as other states, were represented. The exhibition is to be kept permanently at Butte, and will probably be shown at the St. Louis Exposition in 1904.

A full line of papers was read, of which the only one on an electrical subject was by Mr. E. D. Owen, on the location of minerals by electrical means. He said that by the apparatus of his invention, one electrode current entered the earth at one point and another at another point, thus establishing a ground circuit which would cause the path of least resistance, as in reaching the ledge it would have to metallic streak, by changing the location of the electrodes he could determine very nearly exactly the width of the vein. He could also determine how deep the surface of the ledge was. If a 100-foot wire was used, the current would probably not dip to the ledge to find the path of least resistance, as in reaching the ledge it would have to go through the ground 100 feet, the distance between the electrodes. If, however, the rods were 300 feet apart, the current would go to the depth of 50 feet. After locating the ledge and figuring the relative resistance of the ground and the ledge, the depth could be accurately determined by calculation and by setting the rods at varying distances.

It had been suggested that water offering little resistance would interfere with the work, but experiments along this line had shown that such was not the case, as the conductivity of water does not compare with the conductivity of a metal streak. In the Calumet and Hecla, the vein was known to run under a horseshoe strip of water. The electrodes had been set up on the edges of the water, and the resistance had been found to be 1,100 ohms. They had been swung a distance to the side, and the resistance was 550. When moved directly over the ledge, the resistance was 125.

Mr. Owens stated that the normal resistance of the earth was between 16,000 and 20,000 ohms. In the State of Montana he had found it as high as 56,000. In Idaho it was between 7,000 and 9,000, and it declined only 60 ohms over the vein. One peculiar fact was that the lowest readings were nearly always over the foot walls. He told an experience he had in Mexico. Some of the gentlemen who had seen the working of the apparatus said that it would work over large or rich ledges, but they doubted if it would work over ledges that only carried a small quantity of metal. To test the apparatus, it was taken to a known ledge whose values consisted of one-half ounce of gold and one-half ounce of silver and no other metals. The ledge had been located as easily as any others.

Upon the conclusion of the paper, a resolution was passed, accepting an offer to submit the system to a practical test, to be made free of all expense to the congress, in the presence and under the direction of a committee of experts to be appointed by the congress, and the executive committee was directed to appoint a committee of five electrical and mining experts, who shall act for the congress in making these tests, and report the result to the chairman of the executive committee for publication at the next session of the American Mining Congress.

A Discussion of Municipal Ownership.

At the Belfast meeting, last week, of the British Association for the Advancement of Science, Robert P. Porter, director of the Eleventh United States Census, read a paper in the Economic Section, on "Municipal Trading." In the course of his address, Mr. Porter said that the broadest objections to municipal ownership or trading appeared to be six in number—the injurious effect upon the work strictly within the municipal sphere of operation; the fact that in giving attention to trading operations the "unproductive" work was almost certain to be neglected; the tendency to discourage improvement or development; the engendering of ill feeling when the taxpayer found himself obliged to defray the cost of competing with himself; the difficulty of putting the burden of a trading undertaking on the right shoulders, and the impossibility of drawing a line as to which industries should be taken up by municipalities and which should be left to individual enterprises.

Mr. Porter called attention to the fact that in the early part of the last century the various State Governments of the United States entered into financial partnership with the promoters of canals, and later, when steam railways were introduced, States, cities and counties were alike appealed to for assistance in building railways. Mr. Porter said that there had been an epidemic in the forties and fifties, similar to the present fever in England, which swept over the country and ended in bankruptcy and ruin not only of cities and towns, but of important States. Bonds issued by the State and local authorities for the promotion of railways went in default.

These kindred experiences, Mr. Porter explained, taught Americans the useful lesson that there was a limit to State and municipal credit. The taxpayers of those times, who saw their property practically confiscated to pay for enterprises which should have been left to individual endeavor or private speculators, invented a device known as "the debt limit clause," and this clause, in some form or other, was inserted in nearly every State constitution drawn and adopted since those days of financial disaster and destruction of State and local credit.

Partially because of the debt limitation and partially because private enterprise had been allowed a freer headway in such undertakings as the supply of gas, electric lighting, tramways, and telephones, Mr. Porter pointed out that in the United States no city owned and operated its own tramways and street railways, probably less than half a dozen manufactured gas, a very few engaged in supplying electric light, and not one was in the telephone business.

Mr. Porter said that municipal trading was rapidly increasing municipal debt in England, and that serious complaints were heard on all sides in consequence of the increase of local taxation. In regard to the answer that the debt is "productive," and that the profits of these industrial undertakings will be used to reduce the taxes, Mr. Porter called attention to Sir Henry Fowler's statistical classication of indebtedness showing that the so-called "productive" debt is only about half of 1 per cent. beyond the danger line; that is, the dividend or profit from this debit averages half of 1 per cent.

If, in consequence of the anxiety in financial circles at the steady increase of local debt, the rate of interest should rise a half per cent. on all local securities, what would become of the "productive" debt? Mr. Porter asked. Then he stated that, assuming that the trading debt represented one-third of the total local debt, a rise of a quarter per cent. would extinguish the "productive" properties of these loans, and, in a sense, throw them on the rates.

Without suggesting any remedy for municipal trading, the speaker said, an alternative plan would be the leasing system, which, when the contracts were wisely drawn, secured the revenue for the city treasury, and good, cheap service for the public. On the other hand, this would shift the financial risk from the ratepayers' shoulders. This, with some form of debt limitation, would gradually modify existing conditions, especially if backed by a strong public opinion in opposition to further use of public funds in this manner. It was a case for gradual readjustment, not violent change. With the facts fully understood, the people would by degrees curtail these unwise and dangerous economic experiments, and bring cities back to a sphere of work strictly their own.

The Largest Electric Water Power Station in New England.

LEWISTON and Auburn, Maine, occupy opposite banks of Androscoggin River at a point where its fall of fifty feet develops a great water power. Large industries have been built up by the use of this power, the most important of which, the manufacture of cotton cloth, has made the cities famous. Notwithstanding the 18,000-hp which these falls are said to develop at times of only moderate flow, it has been found necessary to resort to steam in some of the mills, as the demand for water power exceeds the supply. This situation is shortly to be relieved by means of electrical transmission.

Just below the falls of the main river and within the city limits of Auburn, the Little Androscoggin, a tributary stream,

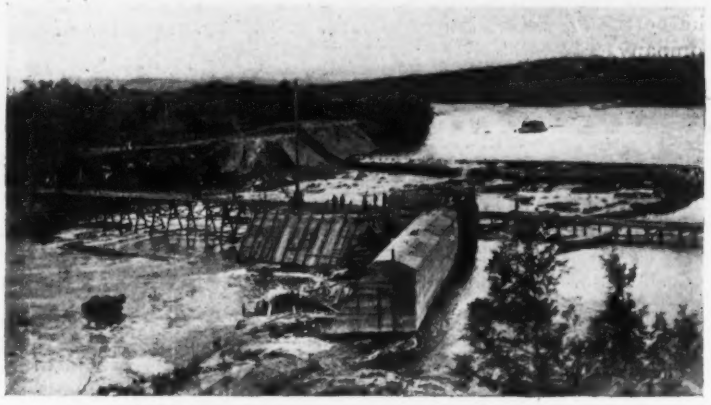


FIG. I.—PART OF DAM AND CRIB.

passes over three falls of several hundred horse power each. At two points on the larger and two on the smaller river, all four within the limits of the cities, the Lewiston and Auburn Electric Light Company operate stations by water power. These four plants have come down from the days of independent, competing companies, and present the usual variety of generating equipment and systems of distribution common to old stations.

By improvements now under way these generating plants will be displaced. At present the two-wire, direct current system at 110 volts, the three-wire at 220 volts, constant current open arcs, 500-volt distribution for direct current motors, and two-phase circuits at 2,200 volts are all represented. Among the equipment is one of the original bi-polar, Edison dynamos with three magnet cores per pole, which carries its daily load of about 250 amperes in a satisfactory way. The generating equipment at these four stations includes five 2,500-volt, 10-ampere arc dynamos, 125-volt dynamos of 90-kw total capacity, 500-volt generators of 350-kw, and two-phase alternators of 690-kw, a total of 1255-kw capacity. All the alternators operate at 60 cycles per second.

The connected load of these four stations is as follows. Open arcs of nominal 2,000-cp each, to the number of 110, are operated on city streets. Commercial arcs number 180, of which 30 are open and 150 enclosed. The enclosed arcs include 65 of the direct and 85 of the alternating type. Twenty-two Nernst lamps of the 1, 2 and 3 glower types are in use for interior lighting. Approximately 15,000 incandescent lamps are connected to the system. Motors make up an important part of the load with a total rated capacity of 484 hp. Nine of these motors, including one of 75-hp, are the two-phase induction type with a total rating of 300 hp. The remaining 184 hp is made up of 37 direct current motors. At present the lines of this system are confined to the two cities, because even there the available loads are greater than they can operate.

The management of the Lewiston and Auburn Company has planned and begun to execute extensions that will carry it far beyond its present moderate loads and limited service area. For some time the company has been unable to operate motor loads that could readily be secured in connection with the manufacturing industries. Within a radius of twenty miles from the cities on the Androscoggin are dozens of towns and villages that would welcome a supply of electric light and power. Within the next few months the Lewiston system will be in a position to supply thousands of horse power to manufacturers and a much wider service area.

Three miles up stream from the great falls of the Androscoggin at Lewiston are Deep Rips, where thousands of horse power, developed by the river at an abrupt descent in its rocky bed, have gone to waste as useless heat for centuries. The management of the Lewiston company have secured this water privilege and are now developing a power to drive an electric station that will have a capacity greater than any of its kind in New England. At this point the bed and sides of the river are solid rock, covered at intervals with a little earth. By a system of crib work successive portions of the river bed are shut off from the water, cleaned of earth and bowlders and sections of the dam built thereon.

This dam is located just above the natural waterfall, so that the head of water obtained will be greater by some feet than the height of the dam. From shore to shore of the river, a distance of 800 feet, this dam will form, when completed, a continuous mass of concrete. A great timber form or bin is built for each section of the dam, and into this bin is dumped the soft concrete as fast as it can be brought to the desired point over a tramway that extends entirely across the river just above the line of the dam.

After one section of the dam has been completed the timbering about it is removed and a new section next to it is started. In this way about 300 cubic yards of dam are being built each 24 hours, as the work goes on day and night. Rock for the concrete is blasted from the site of the canal on one bank of the river as fast as wanted, and is there reduced in a crusher so that the largest pieces pass through a two-inch ring. Concrete for the dam is composed of one part high grade cement, two parts coarse, sharp sand and three parts of the crushed rock. All work on the dam is being done by the day, the owners furnishing the materials.

At its top the dam has a uniform width of six feet, but it varies in height owing to the uneven bed of the river, being 26 feet where this bed is the lowest. Water behind the dam will be raised about twenty feet above its old level and a road along one bank is to be moved to higher ground in consequence.

A pond about three miles long will be formed by the water behind the dam and a valuable storage capacity thus secured. From one end of the dam to a point 600 feet down stream a

FIG. 2.—A SOLID FOUNDATION.

canal is being blasted out of the solid rock. This canal is twenty feet wide and will be faced with stone. In order to furnish power for the stone crusher, light for night work, and to pump water from that portion of the river bed where work is going on, energy at 2200 volts is transmitted from the old water power plants to the site of the new dam over the line that will eventually serve for transmission in the opposite direction. This energy is reduced by transformers to 440 volts at the dam, and there operates a 50-hp motor for the rock crusher and a 5 and 20-hp motor for pumping, besides a number of enclosed arc lamps. Blasting is also carried on with the 440-volt current, 56 holes containing 300 pounds of 75 per cent. dynamite having

recently been fired at once, a result not possible with the equipment previously used.

At the lower end of the canal comes the power house, a brick building, 40 by 200 feet outside, and finished as one story with a steel truss roof. Along one long side of this building will be chambers for ten pairs of horizontal turbine wheels, which are to operate under a head of 32 feet. Each pair of these wheels is rated at 1200 horse power and 180 r. p. m., giving a total of 12,000-hp capacity. An alternator of 750-kw will be direct connected to each pair of turbines, giving a generator capacity of 7500-kw or 10,000 electrical hp.

All of these alternators are of the revolving magnet type and will operate at 10,000 volts, 60 cycles per second, three-phase. A contract for two of these 750-kw. generators has already been made with the General Electric Company. For each alternator the switchboard, located in a gallery above the wheel chambers, will contain one generator and one feeder panel. The output of all the generators will be recorded by wattmeters. Energy passes directly from the alternators and switchboard to the line at 10,000 volts, no raising transformers being used. From the water power plant to the sub-station in Lewiston, a distance of 3.5 miles, the transmission line has been erected on 40 and 45-foot chestnut poles. These poles are set six feet in the ground and 125 feet apart. For the greater part of its length the line follows the public highway, but the portion nearest the sub-station is over a private right of way which makes it possible to use overhead circuits exclusively.

The transmission line consists of two independent circuits of three conductors each, so arranged that the conductors of each circuit are eighteen inches apart. This arrangement is obtained by means of a four-pin cross arm near the top of each pole and

FIG. 3.—MAKING CONCRETE.

a shorter two-pin cross arm just under it. Two conductors of a circuit are mounted at one end of the top cross arm, and the third conductor beneath these two and on the lower cross arm. The other circuit is arranged in a similar manner on the opposite ends of the cross arms. All six of these conductors are bare aluminum and each is made up of seven strands, each strand being number 8 B. & S. gauge. These conductors are erected in mile lengths and joints are made by twisting the conductors after each is passed through a McIntire aluminum sleeve ten inches long. No solder is used at the joints. Most important among the considerations that influenced the erection of two instead of a single circuit was the desire to avoid the effect of large and fluctuating motor loads on circuits that supply the lighting service. One circuit will therefore be used exclusively for power and the other for lamps. Wooden pins treated with parafine are employed for the entire line, and the conductors are mounted on Knowles H. G. glass insulators, each 6¼ inches in diameter at the largest point.

At the sub-station, an existing brick building in Lewiston, transformers of 500-kw each to the number of fifteen are to change the 10,000-volt, three-phase energy to 2200-volt, two-phase for general distribution. The present constant current arc dynamos will eventually be replaced by constant current transformers located at the sub-station, and feeding enclosed arc lamps. No rotary converters are to be installed, but it is the purpose to continue the operation of a 500-volt generator at one of the water powers in Lewiston indefinitely in order to carry the existing load of direct-current motors. Future contracts for power, however, are to be based on the use of induction motors.

When its great water power station is in operation the Lewiston Company will make attractive rates to large users of electric power, and it is believed that this policy will materially increase the importance of the two cities as centers of manufacturing industry. Thanks are due to Mr. H. S. Sands, superintendent of the Lewiston and Auburn Company for the facts here presented concerning this notable water power system.

All of the work on the dam is being done by the day under the personal supervision of Mr. W. S. Libbey, treasurer of the company.

Scientific Industry in England.

An important report has just been issued respecting the recent inquiry of a special sub-committee of the Technical Education Board of the London County Council, on "The Application of Science to Industry." The committee has arrived at the conclusion that "various branches of industry have during the past 20 or 30 years been lost to this country, owing to the competition of foreign countries; that in many others our manufacturers have fallen seriously behind their foreign rivals; and that these losses are to be attributed in no small degree to the superior scientific education provided in foreign countries."

In this connection, reference is made to the transfer from England to Germany of numerous departments of manufacturing chemistry, the best-known instance of loss being the manufacture of aniline dyes and many other valuable products from coal tar. Whereas the original investigations and discoveries on which this industry is based were made almost entirely in England, there are not now a thousand work-people employed in the industry in the Kingdom. On the other hand, it is a most lucrative and flourishing business in Germany. Then the manufacture of high-class lenses for photographic cameras, microscopes, telescopes and field-glasses, as well as of thermometer-glass tube for making thermometers for accurate physical measurements, has practically been lost to the country. Thirdly, the committee points to the rapid development in the United States, Germany and Switzerland of the various branches of the manufacture of electrical machinery, as compared with the relatively slow progress made in the United Kingdom. In 1890 the imports of electrical appliances and scientific apparatus were too insignificant to be separately scheduled. In 1900 they amounted to £1,174,000 and £522,000, respectively.

While some of the witnesses examined attributed the relative backwardness of England in scientific industries partly to other causes, they were practically all agreed in considering it due, in the main, to the deficiencies of the British educational system. It did not appear that the training of the workmen was at fault. It is believed that the opportunities now open to the London workman for obtaining technical education in his trade are actually superior to those enjoyed by the German or American workman. Summing up all the evidence, the committee is convinced that the main causes of British failure in the chemical, optical and electrical industries are the following: (a) The lack of scientific training of the manufacturers themselves, and their consequent inability to recognize the importance of scientific assistance; (b) the defective condition of secondary education, and the consequent lack of sufficiently prepared recruits for advanced technological training; (c) the lack of a sufficient supply of young men who have been trained, not only in scientific principles and method, but also in the application of science to particular industrial processes; (d) the lack of any institution providing advanced technological training which is sufficiently equipped and endowed to enable it to give adequate attention to post-graduate or advance work. There is a concensus of opinion that the highest grade of technical education must be carried on in an institution of university rank during the day. The few hours which can be given in the evening by those who are engaged in business during the day are insufficient for training in research.

U. S. Census Report on Electrical Manufactures.

THE United States Census Office has just issued a report of 53 pages on the manufacture of electrical apparatus and supplies, compiled by Mr. T. C. Martin, as special expert agent, and based on the returns obtained by the Census Office enumerators in 1900, with a subsequent analysis of the figures in as full detail as could be obtained. It is the first separate report made at any census on the subject, and the work was, therefore, without precedent to guide it. While reference is naturally made to the industries of electric lighting, electric railways, telegraphy, telephony, etc., and statistics are given as to their development, the only figures tabulated in Bulletin No. 245, are those which relate specifically to electrical manufactures; while as regards the figures of power employed in all the manufacturing industries of the country, they are included in another elaborate and voluminous bulletin of which Mr. E. H. Sanborn and Mr. Martin are the joint authors. The whole of this interesting and difficult work has been done under the initiative and judicious guidance of Mr. S. N. D. North, the able Chief Statistician for Manufactures of the Twelfth Census, and the success of the entire compilation of manufacturing statistics, on a scale and with a completeness never before attained, is due to the executive energy of General Merriam, head of the Census Department. When it is stated that 512,721 manufacturing establishments of all kinds had to be dealt with, some dim idea of the work in manufactures alone, can be formed.

The total product in the "electrical industries," and the product under the various divisions will be found in the tables presented herewith, all of which, it will be borne in mind, are based upon the signed statements of the manufacturers themselves, and have therefore a weight and value that could not possibly attach to an estimate, however careful. Even thus many difficulties arose in consequence of the endeavor to prevent "duplication" of figures, but it is made clear that the electrical industry is to be credited with much more than is actually assigned to it.

TABLE I.—ELECTRICAL APPARATUS AND SUPPLIES: COMPARATIVE SUMMARY, 1880, 1890 AND 1900, WITH PER CENT. OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.			PER CENT OF INCREASE.	
	1900	1890	1880	1890 to 1900.	1880 to 1890.
Number of establishments	580	189	[1]76	206.9	148.7
Capital	$83,130,943	$18,997,337	$1,509,758	337.6	1,158.3
Salaried officials, clerks, etc., number	4,987	[2]683	[3]	630.2	.....
Salaries	$4,563,112	[2]$849,138	[3]	437.4	.....
Wage-earners, average number	40,890	8,802	1,270	364.6	592.5
Total wages	$20,190,344	$4,517,050	$683,164	347.0	561.2
Men, 16 years and over	34,150	7,289	1,132	368.5	543.9
Wages	$18,369,228	$4,082,847	[3]	349.9	.....
Women, 16 years and over	6,158	1,469	72	319.2	1,940.3
Wages	$1,701,110	$426,660	[3]	298.7	.....
Children, under 16 years	582	44	67	1,222.7	[4]34.3
Wages	$120,006	$7,543	[3]	1,491.0	.....
Miscellaneous expenses	$6,788,314	$1,154,462	[5]	488.0	.....
Cost of materials used	$48,916,440	$8,819,498	$1,116,470	454.6	689.9
Value of products, including custom work and repairing	$91,848,889	$19,114,714	$2,655,036	377.9	619.9

[1] Includes 36 establishments reported as "electrical apparatus and supplies," and 40 reported as "telegraph and telephone apparatus."

[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 26.)

[3] Not reported separately.

[4] Decrease.

[5] Not reported.

For instance, it is pointed, there is probably no more conspicuous object in the average American landscape than the ubiquitous pole employed for the telegraph and telephone line, for the arc-light circuit, or for the trolley car. No poles, whether of wood, iron, or steel, are included in the statistics, it being considered that even if specifically made for such work, they are already embraced in the totals of the lumber and metal industries. There are some concerns, however, that make a feature of wooden cross-arms for poles, and insulator pins, and these, when reporting such product separately, have been included as being legitimately and undeniably electrical. In the same manner a large amount of glass and porcelain is used for electrical purposes—for battery jars, globes, tubes, knobs, insulators, etc., but only those products have been recognized that were reported by concerns with whom this is a distinct branch of business.

TABLE 2.—DYNAMOS: NUMBER, HORSEPOWER, AND VALUE BY STATES, 1900.

STATES.	Number.	Horse-power.	Value.
United States	10,527	770,832	$10,472,576
California	57	1,925	33,297
Colorado	40	875	18,000
Connecticut	408	13,182	263,590
Georgia	23	155	5,210
Illinois	1,102	59,696	868,640
Indiana	521	22,827	355,759
Kentucky	38	566	8,901
Maine	81	925	16,516
Massachusetts	711	53,930	757,486
Michigan	20	772	13,090
Minnesota	135	1,950	30,500
Missouri	25	2,500	35,000
New Hampshire	13	400	5,700
New Jersey	1,147	37,090	612,459
New York	1,220	269,708	3,280,871
Ohio	3,292	38,096	771,164
Pennsylvania	1,236	255,285	8,126,458
Rhode Island	10	400	8,000
Texas	15	600	15,000
Wisconsin	433	9,950	247,000
Direct current	9,182	428,601	6,297,925
Alternating current	1,345	342,231	4,174,651

Under the same generic rule the statistics include neither steel rails employed only for the construction of trolley systems nor bare iron and copper wire of any kind or size. It is a notorious fact that the annual consumption of bare iron and copper wire in the electrical arts runs into millions of pounds, most of it being of such diameters that outside of electrical applications it has no use whatever. Equally true is it that in electric railway work heavy steel rail is often used unknown to steam railway work, associated with special frogs and switches built for each case. But so far as can be determined none of this material has now been brought to account, and the only bare copper wire of which the value is given is that worked up into the form of "rail bonds" manufactured and used solely with the object of increasing at rail joints the conductivity of trolley tracks when serving as part of the return circuit.

It is true, of course, that some part of the total value shown is counted twice, but that is unavoidable. The duplication would appear to occur chiefly in regard to insulated wire. The item is set apart by itself, but owing to the enormous range of size of wire covered, as well as the fact that much of it is also laid up in cables, the value is not accompanied by any length in feet or weight in pounds. It would have been very interesting to know the actual consumption of copper by the electrical industries, but there are no data available as to the wire drawn for that purpose, and if there were, the figures would still be very incomplete, owing to the large electrical use of copper rods, bars, drop forgings, commutator segments, strips, leaf, etc. On the other hand, anticipating another part of this report, it is noted that virtually the whole American industry of copper refining is a branch of electrical manufacture. The production of copper in the United States is placed at 275,000 metric tons in 1900. According to the best authorities, in 1899 no less than 198,600 short tons was produced electrolytically. Mr. Charles Kirchhoff, expert special agent of the Census for copper refining and smelting, states that so far as the employment of the electrolytic refining process is concerned it is now applied practically to all copper produced in the United States outside of that

made from Lake Superior copper, but even a part of this is also electrolytically treated at the Buffalo works of the Calumet & Hecla Company.

Offsetting and far outweighing any possible reduction of the total here given for American electrical manufactures, on the score of duplication, is the vast and incalculable amount of work done by many large industrial concerns for themselves. To what an extent this may be carried is evidenced by the figures of the Union Iron Works, of San Francisco, Calif., builders of the battleship "Oregon" and other men-of-war. In 1896 this works

TABLE 3.—DYNAMOTORS, MOTOR GENERATORS, AND BOOSTERS: NUMBER, HORSE-POWER, AND VALUE BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.			Establishments reporting values only.
		Number.	Horse-power.	Value.	
United States	$379,747	649	14,397½	$354,747	$25,000
Connecticut	50	1	½	50	.....
Illinois	18,037	194	325	18,037	.....
Indiana	1,287	7	43	1,287	.....
Massachusetts	2,112	36	50	2,112	.....
Missouri	2,000	20	100	2,000	.....
New Jersey	82,091	245	3,450	82,091	.....
New York	201,665	39	8,584	201,665	.....
Ohio	20,850	11	1,054	20,850	.....
Pennsylvania	51,655	96	791	26,655	25,000

began the manufacture of electrical apparatus required in every line of its work with the result that at times no fewer than 300 hands have been employed in its electrical department, and that at the present time all that is required in the line of generators, motors, switchboards, steering gear, ammunition hoists, turret turning, ventilating apparatus, bells, annunciators, signals, tell-tales, etc., is designed and built in the yards. Nor is this all, for the supersession of steam in the operations of shipbuilding has been attended by the introduction of electric cranes, etc., all of which also have been designed and built on the spot. An establishment of this kind is quite outside the electrical field in public estimation, but it is obvious that if it were not thus self-centred a corresponding product from regular electrical manufacturing concerns would have been demanded and would, to that extent, have swollen the figures for California and other States. Within the electrical field the public-service companies are numerous that do their own "custom and repair work," and from the Western Union Telegraph Company, the New York Edison Company, the Boston Elevated Railroad Company, the Pacific States Telephone Company, down through thousands of local lighting, trolley, telephone, and power companies, it would be difficult to find one of any magnitude that does not maintain its own shop,

TABLE 4.—TRANSFORMERS: NUMBER, HORSE-POWER, AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.			ESTABLISHMENTS REPORTING VALUES ONLY.
		Number.	Horse-power.	Value.	
United States	$2,962,871	36,513	407,451	$2,960,171	$2,700
Illinois	37,516	1,234	5,185	37,166	350
Indiana	94,730	2,400	12,250	94,730	.....
Massachusetts	951,014	23,799	120,190	951,014	.....
Missouri	270,600	3,775	37,600	270,600	.....
New Hampshire	600	2	60	600	.....
New York	723,908	436	103,366	723,908	.....
Ohio	100,850	2,505	12,900	98,500	2,350
Pennsylvania	783,653	2,362	115,900	783,653	.....

with an invisible line of demarcation between new custom work and repairs.

While certain leading lines of American manufacture are subject to limitations imposed by the demand for or competition of foreign goods, it cannot be said that the electrical industries are conscious of any check of this kind. On the contrary, there has grown up a steady export trade which would be very much larger, but for the fact that the American apparatus sent abroad having at once proved popular and attractive, the patent rights for its manufacture in Europe have been purchased or arrange-

ments made for drawings and patterns. Hence, American electrical factories are now located all over Europe, under one name or another, in Paris, Berlin, Havre, London, Antwerp, and other cities, and their product embodies American ideas, or capital, or direction or labor, sometimes all four. These factories employ thousands of men, and it is only fair to point out that the increase

TABLE 5.—SWITCHBOARDS FOR LIGHT AND POWER: NUMBER AND VALUE, BY STATES, 1900.

STATES.	SWITCHBOARDS.	
	Number.	Value.
United States	6,422	$1,846,624
California	20	10,000
Colorado	60	8,000
Connecticut	15	3,700
Delaware	1	1,500
Illinois	180	75,367
Indiana	30	14,944
Louisiana	2	50
Massachusetts	143	230,602
Michigan	3	880
Minnesota	10	500
Missouri	35	67,500
New Jersey	12	1,890
New York	2,506	1,055,288
Ohio	46	21,660
Pennsylvania	3,354	353,043
Rhode Island	1	200
Wisconsin	4	2,000

in the export of American electrical manufactures would be enormous but for this natural and inevitable restriction. The export of electrical apparatus in the census year 1900, amounting to $5,000,000 might easily have been five times as much but for the facts just noted. On the other hand, the electrical importations have been checked by corresponding conditions in the United States, though in much lesser degree, and are confined to but one or two specialties.

As to electrochemistry and electrometallurgy Mr. Martin notes a very large class of products which are essentially electrical manufacturing, but of which no figures at all are included. The reasons for their exclusion are generally of the same nature as those applying to the exclusion of electrolytically refined copper, which has been shown to mean most of the copper refined in the United States. But this branch of the electrical art can not be overlooked, and a few figures in regard to it have been collated during the course of the inquiry. Already at Niagara Falls alone about 35,000 hp is used electrically in some twenty different processes for reducing metals or chemicals; all of this work growing up in the period between the Eleventh and Twelfth censuses. Among these industries may be mentioned the production of aluminum, which, owing to its electrical manufacture,

TABLE 6.—SWITCHES: NUMBER AND VALUE, BY STATES, 1900.

STATES.	SWITCHES.	
	Number.	Value.
United States	1,723,387	$1,129,891
California	700	1,125
Colorado	42,000	28,500
Connecticut	1,415,000	382,810
Illinois	2,000	3,000
Massachusetts	20,000	237,762
Missouri	108	1,380
New Jersey	31,200	21,932
New York	7,435	191,027
Ohio	1,286	7,515
Pennsylvania	203,458	254,340
Rhode Island	200	500

has become so cheapened that it competes with copper as a conductor, and has found its way into a great many arts. The production of aluminum by electricity in America in the census year 1899-1900 is placed at 6,500,000 pounds, valued at $2,112,500. Another article is calcium carbide, from which acetylene gas is obtained, and which was first made commercially about 1895, in the United States. The quantity of this manufactured in the census year at Niagara was, it is stated, at the rate of about 12,000 tons per annum. Another notable product is that known as carborundum, in which silicon and carbon are doubly united by the

TABLE 7.—MOTORS: NUMBER, HORSE-POWER, AND VALUE OF VARIOUS KINDS, BY STATES, 1900.

STATES.	Aggregate value.	DIRECT AND ALTERNATING CURRENT.			FOR RAILWAYS.			FOR AUTOMOBILES.		
		Number.	Horse-power.	Value.	Number.	Horse-power.	Value.	Number.	Horse-power.	Value.
United States	$19,505,504	35,604	515,705	$7,551,480	15,284	666,669	$7,568,841	3,017	8,220	$192,080
California	56,500	.....	.....	.....	.....	.....	.....	.....	.....	.....
Colorado	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
Connecticut	97,597	455	4,328	86,560	.....	.....	.....	290	638	11,037
Georgia	6,000	30	200	6,000	.....	.....	.....	.....	.....	.....
Illinois	970,701	1,688	7,780	167,638	.....	.....	.....	1,440	2,870	156,823
Indiana	105,904	643	4,613	96,364	.....	.....	.....	.....	.....	.....
Iowa	750	6	50	750	.....	.....	.....	.....	.....	.....
Kentucky	18,060	98	655	15,620	.....	.....	.....	.....	.....	.....
Louisiana	60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maine	40,174	121	2,200	35,910	.....	.....	.....	3	15	375
Massachusetts	1,892,500	6,393	23,754	410,176	4,078	94,791	1,095,069	2	2	200
Michigan	318,304	114	584	9,796	.....	.....	.....	.....	.....	.....
Minnesota	13,500	64	700	13,500	.....	.....	.....	.....	.....	.....
Missouri	175,180	598	6,110	91,705	.....	.....	.....	.....	.....	.....
Nebraska	23,200	110	1,100	19,600	.....	.....	.....	.....	.....	.....
New Hampshire	13,149	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Jersey	2,073,555	9,268	86,873	1,501,755	.....	.....	.....	.....	.....	.....
New York	4,470,881	3,996	80,990	1,222,255	4,746	214,749	2,120,000	52	120	12,000
Ohio	1,370,412	1,414	21,279	366,766	1,100	35,629	432,051	1,230	4,575	11,595
Pennsylvania	7,503,791	9,067	263,202	3,204,058	5,360	321,500	3,921,721	.....	.....	.....
Wisconsin	343,286	1,539	11,287	303,027	.....	.....	.....	.....	.....	.....
Direct current	.....	29,615	378,329	5,786,052	.....	.....	.....	.....	.....	.....
Alternating current	.....	5,989	137,376	1,765,428	.....	.....	.....	.....	.....	.....

TABLE 7.—MOTORS: NUMBER, HORSE-POWER, AND VALUE OF VARIOUS KINDS, BY STATES, 1900.—*Continued.*

STATES.	FOR FANS.			FOR ELECTRIC ELEVATORS.					MISCELLANEOUS.		
	Number.	Horse-power.	Value.	Total value.	Establishments reporting quantities and values.			Establishments reporting values only.	Number.	Horse-power.	Value.
					Number.	Horse-power.	Value.				
United States	97,577	12,766	$1,055,369	$2,523,901	385	6,730	$515,446	$2,008,455	7,913	11,892	$613,883
California	.....	.....	.....	35,000	30	1,500	35,000	.....	270	1,085	21,500
Colorado	150	2,005	2,000	.....	.....	.....	.....	.....	100	570	10,000
Illinois	15,046	755	130,281	506,359	153	1,500	40,000	466,359	486	450	9,600
Indiana	15	65	1,300	.....	.....	.....	.....	.....	206	103	8,240
Kentucky	90	100	900	.....	.....	.....	.....	.....	20	16	1,540
Louisiana	3	[1]	60	.....	.....	.....	.....	.....	.....	.....	.....
Maine	.....	.....	.....	3,889	7	115	3,889	.....	.....	.....	.....
Massachusetts	18,330	1,760	183,120	152,335	120	3,240	152,335	.....	172	1,474	51,600
Michigan	131	178	12,508	296,000	.....	.....	.....	296,000	.....	.....	.....
Missouri	5,195	[1]	82,500	.....	.....	.....	.....	.....	200	20	975
Nebraska	.....	.....	.....	.....	.....	.....	.....	.....	80	8	3,600
New Hampshire	1,200	100	10,449	.....	.....	.....	.....	.....	45	36	2,700
New Jersey	22,857	2,525	251,208	300,592	.....	.....	.....	300,592	2,000	100	20,000
New York	14,560	2,333	152,051	945,504	.....	.....	.....	945,504	212	571	19,071
Ohio	13,200	1,595	153,000	.....	.....	.....	.....	.....	2,960	6,050	407,000
Pennsylvania	6,800	1,350	75,992	261,722	60	[1]	261,722	.....	697	884	40,298
Wisconsin	.....	.....	.....	22,500	15	375	22,500	.....	471	25	17,759

[1] Horsepower not reported.

TABLE 8.—BATTERIES, STORAGE AND PRIMARY: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Aggregate value.	STORAGE.				PRIMARY.							
		Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Total value.	Liquid.				Dry.		Value of parts.
			Number.	Value.			Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Number.	Value.	
								Number.	Value.				
United States	$3,679,045	$2,559,601	11,012,035	$2,482,228	$77,373	$1,119,444	$571,370	708,077	$569,870	$1,500	1,946,688	$316,013	$232,061
Connecticut	500	.....	.....	.....	.....	500	.....	.....	.....	.....	.....	.....	500
Illinois	425,479	97,538	200,400	21,000	76,538	327,941	247,588	214,135	247,588	.....	41,500	7,875	72,478
Indiana	41,252	.....	.....	.....	.....	41,252	39,552	133,561	39,552	.....	5,000	700	1,000
Iowa	12,000	.....	.....	.....	.....	12,000	12,000	15,000	12,000	.....	.....	.....	.....
Maryland	47,969	1,200	600	1,200	.....	46,769	.....	.....	.....	.....	10,000	46,769	128,125
Massachusetts	134,461	835	.....	.....	835	133,626	5,501	2,887	4,001	1,500	.....	.....	.....
Missouri	61,610	5,610	323	5,610	.....	56,000	56,000	40,000	56,000	.....	.....	.....	.....
New Jersey	116,524	.....	.....	.....	.....	116,524	5,000	50,000	5,000	.....	1,100,000	100,000	11,524
New York	432,692	104,848	6,619	104,848	.....	327,844	195,010	241,700	195,010	.....	451,000	116,000	16,834
Ohio	280,330	225,311	7,563	225,311	.....	55,019	10,350	[1]10,200	[1]10,350	.....	339,188	44,669	.....
Pennsylvania	2,126,228	2,124,259	10,796,530	2,124,259	.....	1,969	369	594	369	.....	.....	.....	1,600

electric current, an artificial abrasive resulting that vies with the diamond in cutting power. Carborundum is now being sold in all the civilized countries of the world, and in 1900-1901 the American production was not less than 3,800,000 pounds, at 10 cents per pound. Incidental to this process has been that of producing graphite electrically, and one plant at Niagara, in 1900-1901, turned out over 1,400,000 pounds.

In the report of the chemical industry, by Professor Munroe, cited by Mr. Martin, it is stated that by means of electricity, sodium and other metals, caustic soda, bleaching powder and other bleaching agents, bromine and potassium bromide, potassium chlorate, litharge, graphite, calcium carbide, carborundum, carbon disulphide, and phosphorus were being produced in the census year to a value of $2,045,535 at 14 establishments with a capital of $9,173,000 and employing 739 wage earners. These figures are exclusive of those relating to aluminum.

The amount of money spent each year by each member of the community for the necessities of life and its luxuries affords a measure of the extent to which the various arts and industries rank in importance in promoting the comfort and welfare of the public. It would seem, from the investigation that the average annual expenditure on electricity in the United States for every individual of a population not far from 75,000,000 was $7 per head. Of this amount about $1.25 per head would represent the demand for electric apparatus and supplies; the income of the electric traction companies would reach not less than $3 per head, while that from electric lighting would reach about $1.50. The returns available would also indicate that not less than 75 cents would represent the expenditure on telephone service, and 50 cents per head the outlay for telegraph, fire alarms, and kindred work. These values, which are conservatively put, are, however, rapidly increasing. At least one explanation of the rapid rise of the United States to its present position in international affairs and among the manufacturing nations may be found in this manifest willingness of its people to pay as much for electricity as for bread.

Up to the period of dynamo development and utilization, electrical manufacture depended for its resources of current upon primary batteries. With the perfection of the dynamo and its production as an ordinary piece of manufactured apparatus, great new arts at once sprang into being, the transition being so sharp and sensational that in the figures of the present report, covering $100,000,000 of apparatus, at least 75 per cent of the manufactured goods belong in classes that were unavailable to the public in the days of the primary battery, and would still be inaccessible if it were still the sole source of current supply.

In 1900, it appears, there were 580 establishments, with a capital invested of $83,130,943, and with a total output, including custom work and repairing, of $91,348,889. It has been pointed out by Mr. Martin how these gross figures are susceptible of enlargement for various reasons; and he states that in the course of the investigation the returns of 712 establishments were considered, all of which embraced some product of an electrical nature, bringing the value of such product up to an apparent total of $104,738,719. The supplementary concerns thus noted have not, however, been included, nor their output, as there would be serious difficulty in apportioning to electricity the part of capital, labor, charges, etc., that might be fairly due that item as compared with other items of output from the same factory. It is indeed essential to point out that of the material used in electrical manufacturing establishments, very little is purchased in "raw" or crude form. The returns show that materials valued at no less than $46,272,533 were purchased in partially manufactured form.

The 580 establishments report 384 proprietors and firm members, but do not give the number of stockholders. There were 516 officers of various corporations and 4,471 superintendents, managers, clerks, and salesmen. All these are salaried employees, as distinguished from wage-earners. In the latter category the greatest number employed at any one time during the census year was 50,389, and the least number 32,582. To avoid misconception it should be stated distinctly that these statistics do not include management or workers in the fields of telegraphy, electric railways, electric lighting, etc., in which the ap-

TABLE 9.—CARBONS: NUMBER, KIND, AND VALUE, BY STATES, 1900.

STATES.	Aggregate value.	LIGHTING.				BATTERY.		BRUSHES.		FURNACE.		MISCELLANEOUS.			
		Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Number.	Value.	Number.	Value.	Number.	Value.	Total value.	Establishments reporting quantities and values.		Establishments reporting values only.
			Number.	Value.									Number.	Value.	
United States..	$1,731,248	$1,263,732	172,955,922	$1,262,623	$1,109	355,583	$30,777	5,701,143	$136,679	41,749	$10,974	$289,086	12,176,522	$283,625	$5,461
Illinois	170											170	20,000	170	
Indiana	182,000	182,000	28,000,000	182,000											
New Jersey	43,067					319,583	27,864	373,294	9,742			5,461			5,461
New York	17,667	2,713	65,118	1,604	1,109	36,000	2,913	120,238	12,041						
Ohio	1,311,560	970,202	132,414,866	970,202				3,959,285	90,129	36,749	8,974	242,255	12,000,000	242,255	
Pennsylvania	176,784	108,817	12,475,938	108,817				1,248,326	24,767	5,000	2,000	41,200	156,522	41,200	

TABLE 10.—ARC LAMPS, OPEN AND INCLOSED: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	OPEN.		INCLOSED.	
		Number.	Value.	Number.	Value.
United States	$1,827,771	23,656	$276,481	134,531	$1,551,290
Connecticut	18,093	1,391	18,093		
Illinois	120,361	6,297	57,307	6,025	63,054
Indiana	91,980	2,193	30,696	5,322	61,284
Massachusetts	729,815	8,291	100,000	56,874	629,815
New Jersey	126,705	222	1,880	8,180	124,825
New York	231,367	2,612	39,605	18,655	191,762
Ohio	311,500	950	12,200	26,100	299,300
Pennsylvania	195,950	1,500	14,700	13,375	181,250
Rhode Island	2,000	200	2,000		

TABLE 11.—SEARCHLIGHTS AND PROJECTORS: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Number.	Value.
United States	8,283	$225,635
Illinois	475	46,050
Louisiana	1	30
Michigan	4	400
New Jersey	30	6,500
New York	7,689	162,655
Ohio	80	8,000
Wisconsin	4	2,000

TABLE 13.—DECORATIVE MINIATURE LAMPS, X-RAY BULBS, VACUUM TUBES, ETC.: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Number.	Value.
United States	397,432	$72,935
California	4,825	2,800
Connecticut	10,450	3,800
Illinois	125	285
Maryland	200	50
Massachusetts	250	1,000
New Jersey	214,082	12,500
New York	150,000	46,000
Ohio	7,500	1,500
Rhode Island	10,000	5,000

TABLE 12.—INCANDESCENT LAMPS: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Aggregate value.	16 CANDLEPOWER.		BELOW 16 CANDLEPOWER FOR LIGHTING SERVICE.		ABOVE 16 CANDLEPOWER.		SOCKETS, BASES, ETC.			Establishments reporting values only.
		Number.	Value.	Number.	Value.	Number.	Value.	Total value.	Establishments reporting quantities and values.		
									Number.	Value.	
United States	$4,036,112.	21,191,131	$2,910,023	2,906,817	$308,626	1,222,250	$223,534	$593,929	12,099,400	$468,279	$125,650
Colorado	32,000	196,200	29,500	6,750	1,000	4,050	1,500				
Connecticut	428,357	395,980	63,357					365,000	8,876,400	365,000	
Illinois	101,850	571,919	94,850	10,000	2,500	9,000	4,500				
Kentucky	20,400	120,000	20,400								
Massachusetts	663,278	3,269,615	491,415	2,000	200	90,000	61,663	110,000	15,000	10,000	100,000
Missouri	159,280	796,403	159,280								
New Jersey	1,130,803	8,019,787	813,067	2,176,951	200,510	872,420	91,576	25,650			25,650
New York	46,956	220,000	31,956			30,000	15,000				
Ohio	1,034,580	5,738,044	880,869	711,116	104,416	216,780	49,295				
Pennsylvania	325,329	1,863,183	325,329								
Rhode Island	93,279							93,279	3,208,000	93,279	

TABLE 14.—ELECTRIC LIGHT FIXTURES: VALUE, BY STATES, 1900.

STATES.	Value.	STATES.	Value.
United States	$2,665,124	Minnesota	$6,625
		Missouri	21,350
California	60,000	New Jersey	34,327
Connecticut	14,986	New York	1,551,051
Illinois	254,362	Ohio	193,795
Massachusetts	79,081	Pennsylvania	426,297
Michigan	9,500	Rhode Island	13,750

TABLE 16.—PHONOGRAPHS AND GRAPHOPHONES: SUMMARY FOR 1900.

	1900.
Number of establishments	11
Capital	$3,348,282
Salaried officials, clerks, etc., number	144
Salaries	$179,145
Wage-earners, average number	1,267
Total wages	$608,490
Men, 16 years and over	1,114
Wages	$565,076
Women, 16 years and over	146
Wages	$42,914
Children, under 16 years	7
Wages	$500
Miscellaneous expenses	$215,401
Cost of materials used	$827,529
Value of products, including custom work and repairing	$2,246,274

TABLE 15.—TELEPHONES: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Aggregate value.	RECEIVER AND TRANSMITTER SETS.		INTERIOR SYSTEMS.		CENTRAL SWITCHBOARDS.				SUPPLIES.
		Number.	Value.	Number.	Value.	Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Value.
							Number.	Value.		
United States	$10,512,412	797,246	$3,570,616	217,188	$1,837,266	$3,779,794	1,002	$2,650,396	$1,129,398	$1,324,736
California	296,016					150,301	5	150,301		145,715
Connecticut	105,161	5,000	40,800	8,406	57,161	7,200	5	7,200		
Delaware	3,000			200	2,000	1,000	1	1,000		
Illinois	5,418,528	142,202	1,142,504	203,610	1,687,212	2,282,645	534	2,282,645		306,167
Indiana	189,550	2,000	19,800			62,750	175	62,750		107,000
Iowa	375					375	5	375		
Maryland	120,567	11,000	108,487	400	10,080	2,000	5	2,000		
Massachusetts	503,734	77,511	157,780	554	5,288					340,666
Michigan	270,110	15,000	90,000			35,000	26	35,000		145,110
Minnesota	23,136	3,750	19,536			3,600	20	3,600		
Missouri	89,070	8,000	83,650			5,420	42	5,420		
New Jersey	21,700	21,000	21,700							
New York	2,765,994	460,500	1,523,246	575	52,000	1,159,898	26	30,500	1,129,398	30,850
North Carolina	82,403	5,714	55,000							27,403
Ohio	272,667	22,038	94,578	1,044	6,770	28,600	66	28,600		142,719
Pennsylvania	197,396	10,931	89,790	2,314	15,500	13,000	42	13,000		79,106
Wisconsin	153,005	12,600	123,745	85	1,255	28,005	50	28,005		

TABLE 17.—TELEGRAPH INSTRUMENTS: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Aggregate value.	INTELLIGENCE (KEY, SOUNDER, ETC.).				POLICE, FIRE, DISTRICT, AND MISCELLANEOUS.				SWITCHBOARDS.			
		Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Total value.	Establishments reporting quantities and values.		Establishments reporting values only.	Total value.	Establishments reporting quantities and values.		Establishments reporting values only.
			Number.	Value.			Number.	Value.			Number.	Value.	
United States	$1,642,266	$354,212	199,410	$348,912	$5,300	$1,231,167	40,264	$436,756	$794,411	$56,887	9,101	$53,517	$3,370
California	1,000					1,000			1,000				
Connecticut	61,048					61,048			61,048				
Illinois	52,958	5,320	20	20	5,300	41,268	10,000	30,000	11,268	6,370	1,000	3,000	3,370
Kentucky	62,204					62,204	1,200	62,204					
Maryland	85,000					85,000	6,000	85,000					
Massachusetts	215,004					214,904			214,904	100	1	100	
Missouri	14,400					14,400	1,000	14,400					
New Jersey	366,500	25,000	20,000	25,000		336,500			336,500	5,000	1,000	5,000	
New York	634,261	323,892	179,390	323,892		264,952	22,064	245,152	19,800	45,417	7,100	45,417	
Ohio	6,000					6,000			6,000				
Pennsylvania	143,891					143,891			143,891				

paratus produced is put into operation. Of the factory wage-earners thus employed the largest number of men, 16 years and over, was 37,298; of women, 16 years and over, 6,975; and of children, under 16 years, 679. The last two months of the year appear to be the most active in the factories, although very steady work the year round is indicated, the growing variety of electrical apparatus tending to equalize the output throughout all seasons, although outdoor construction of lines and connections ceases in many States during the winter. While the demand for lighting may fall off in the summer months, that for fan motors comes in, for example, and while factories equipped with electrical power make a lesser use of current when the days are long, the trolley car has then its heaviest burden of excursion travel.

It is noted that 19 States are separately enumerated in the general returns, New York leading the list with 134 establishments,

TABLE 18.—INSULATED WIRE AND CABLE: VALUE, BY STATES, 1900.

STATES.	Value.	STATES.	Value.
United States	$21,292,001	New Hampshire	$96,793
		New Jersey	4,701,574
California	65,905	New York	6,119,878
Connecticut	938,075	Ohio	15,512
Illinois	722,069	Pennsylvania	2,696,155
Indiana	330,000	Rhode Island	3,912,584
Massachusetts	693,456		

Illinois coming second with 82, and Ohio and Pennsylvania closely contesting third place with 64 and 63, while Massachusetts has no fewer than 54. On the other hand, in gross value of output Pennsylvania heads the list with $20,967,587, as compared with $17,697,352 for New York, $11,641,177 for Illinois, and $8,259,612 for Massachusetts. New Jersey has also an excellent standing as a producer of electrical apparatus, with 35 establishments showing a value of $7,380,139, or more than Ohio, with $7,036,103. The preponderance of the Eastern States in the field of electrical manufacturing is shown by the fact that the six States—Pennsylvania, New York, New Jersey, Massachusetts, Rhode Island, and Connecticut—with 316 establishments, produced goods to the value of $59,470,637. The industry, however, is apparently not undergoing any process of consolidation so far as plants are concerned, for while control and management center chiefly in New York, Philadelphia, Boston and Chicago, there are only six establishments reported of over 1,000 hands, while 322 employ between 5 and 50, widely scattered all over the Union.

The general figures do not reveal any tendency to excessive capitalization, for the capital of $83,130,943 is actively employed in producing a yearly product greater than itself in the census period by $8,000,000. This may be explained in part by the fact that the largest producing company had reduced its capital by about one half not long prior to the census year, but has since restored to the present stockholders the amount thus mulcted, on account of the reparation of losses and the steady earning of a profitable income. It has been asserted in economic circles that

TABLE 19.—ELECTRICAL CONDUITS: NUMBER OF FEET AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number of feet.	Value.	
United States	$1,066,163	14,875,386	$545,835	$520,328
California	14,160	200,000	14,160	.....
District of Columbia	21,562	.....	.....	21,562
Massachusetts	353,424	9,936,378	353,424	.....
New York	521,185	4,739,008	178,251	342,934
Ohio	42,381	.....	.....	42,381
Pennsylvania	113,451	.....	.....	113,451

electrical development has done its share in the creation of "securities" and "values" as a result of the combination and consolidation tendencies of the time, but the statistics of electrical manufacturing, Mr. Martin remarks, would appear to be quite clear from such criticism.

Each of the accompanying tables is accompanied by a brief review of development in the census decade. Some of the branches, such as electric lighting, telegraphy, electric railways, and telephony, have had historical consideration in a greater or less degree in the previous censuses; but in most cases, it is wholly new ground from the manufacturing standpoint; and Mr. Martin, with the aid of many of the makers, inventors and others, has tried to set forth briefly the industrial growth of the specific

TABLE 20.—RHEOSTATS AND RESISTANCES, ELECTRIC HEATING AND COOKING APPARATUS, WELDING, ETC.: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number.	Value.	
United States	$1,186,878	94,147	$1,011,997	$174,881
Illinois	29,342	1,410	16,356	12,986
Indiana	60,156	.....	.....	60,156
Louisiana	60	5	60	.....
Maryland	13,200	1,050	13,200	.....
Massachusetts	97,400	.....	.....	97,400
Michigan	32,269	6,200	32,269	.....
Minnesota	4,000	320	4,000	.....
New Jersey	147,349	5,758	147,349	.....
New York	465,836	63,800	465,382	454
Ohio	163,849	1,050	163,849	.....
Pennsylvania	55,210	12,204	51,325	3,885
Wisconsin	118,207	2,350	118,207	.....

electrical arts—so briefly in fact as to show that a good deal of electrical history has still to be written.

With regard to electric motors, figures are quoted from the Sanborn-Martin power report as to their use in factories. It appears that of the total horse-power in manufacturing establishments was 11,300,081, only 311,016 horse-power owned, represented by 16,923 motors, and 183,682 horse-power rented was

TABLE 21.—ANNUNCIATORS, ETC.: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number.	Value.	
United States	$224,885	57,022	$199,565	$25,320
California	5,000	500	5,000	.....
Illinois	30,233	750	4,913	25,320
Massachusetts	20,856	22,748	20,856	.....
Michigan	2,426	4,044	2,426	.....
New Jersey	20,000	10,000	20,000	.....
New York	125,760	14,461	125,760	.....
Pennsylvania	20,610	4,519	20,610	.....

electrical. In other words, 4.4 per cent. of manufacturing power was electrical. It is, however, to be observed that the increase in electrical power plant owned, from 1890 to 1900, was not less than 1,897 per cent., the amount in the earlier year being only 15,569 horse-power. This is an enormous increase, but the regime of electric power in factories had barely begun before 1900;

TABLE 22.—ELECTRIC CLOCKS: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number.	Value.	
United States	$132,149	9,180	$132,039	$110
Illinois	10,000	4,200	10,000	.....
Maine	800	75	800	.....
Massachusetts	39,453	313	39,343	110
Michigan	2,750	1,000	2,750	.....
Minnesota	600	50	600	.....
New York	78,546	3,542	78,546	.....

while every increase in the number and capacity of motors will be generally represented by a corresponding capacity in the steam or hydraulic generating plant, as the motor does not displace these, but is adopted as a better means of distributing their energy than long lines of shafting, belts, and pulleys. Moreover, there is an illimitable use of electric motors outside manufacturing plants, as, for instance, in operating the auxiliary appar-

atus of large steam plants, in mines, in waterworks, on docks, in warehouses, on steamships, in office buildings, etc. As to electric power transmission, this is also discussed at length in the power report referred to. An effect of the improvement in electrical manufacturing and a better grasp of its underlying principles is seen in the notable results as to the development

TABLE 23.—LIGHTNING ARRESTERS, FUSES, ETC.: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number.	Value.	
United States	$595,497	11,264,570	$515,636	$79,861
Illinois	88,400	4,053,150	88,400	.....
Indiana	60,157	.....	.....	60,157
Iowa	30,700	8,325	30,700	.....
Massachusetts	19,704	.....	.....	19,704
New Hampshire	4,110	1,500	4,110	.....
New York	314,763	6,015,945	314,763	.....
Ohio	51,823	1,085,550	51,823	.....
Pennsylvania	840	100	840	.....
Rhode Island	25,000	100,000	25,000	.....

of water power. Apparently, the use of water power for manufacturing purposes has decreased relatively in thirty years from nearly one-half of the motive power to less than one-sixth, but the figures of manufacturing industry do not do, and cannot be expected to do, justice to the growth of the utilization of water power as a means of obtaining electric current for light, heat, electrochemical processes, electrometallurgical work, etc. It is pointed out that there is no inclusion of the figures for electric

TABLE 24.—ELECTRICAL MEASURING INSTRUMENTS: NUMBER AND VALUE, BY STATES, 1900.

STATES.	Total value.	ESTABLISHMENTS REPORTING QUANTITIES AND VALUES.		Establishments reporting values only.
		Number.	Value.	
United States	$860,265	25,921	$584,033	$276,232
Connecticut	43,200	600	6,000	37,200
Illinois	94,538	8,104	78,538	16,000
Massachusetts	89,360	1,210	6,860	82,500
New Hampshire	57,000	.....	.....	57,000
New Jersey	482,635	15,607	482,635	.....
New York	25,356	400	10,000	15,356
Pennsylvania	68,176	.....	.....	68,176

launches or electric carriages, one going under shipbuilding and the other under the carriage industry. The production of electric automobiles in the census year was 1,575 vehicles, of a value of $2,873,464, out of a total of 4,192, valued at $4,899,433, of all classes. The statistics given in Table 7 would include part of this electrical product, as the figures given of 3,017 motors for electric automobiles, of 8,220-hp, and valued at $192,030, are in general reported by concerns not in the carriage field. In other words, the motors are built by regular electrical manufacturers

TABLE 25.—ALL OTHER PRODUCTS: VALUE, BY STATES, 1900.

STATES.	Value.	STATES.	Value.
United States	$14,634,984	Massachusetts	$3,203,943
		Michigan	14,150
California	69,349	Minnesota	102,000
Colorado	5,000	Missouri	48,117
Connecticut	445,449	Nebraska	18,350
Delaware	5,202	New Jersey	1,159,979
Georgia	3,500	New York	1,915,108
Illinois	3,218,171	Ohio	1,285,431
Indiana	308,582	Pennsylvania	2,225,336
Iowa	39,882	Rhode Island	294,893
Kentucky	5,085	Tennessee	36,157
Louisiana	21,200	Texas	53,115
Maine	9,471	Wisconsin	146,064
Maryland	1,500		

to meet the necessities of carriage builders and miscellaneous automobile manufacturers. Some of the automobile concerns have built their own motors, but many, even of the largest, have bought from outside motor makers, or have had the motors constructed in separate electrical shops which they owned or controlled. The noninclusion of electrical automobiles, avoids any possible duplication, although it may err conservatively by not including motors built by those who are enumerated specifically in the carriage schedules.

In spite of the careful and somewhat minute division of the production of electrical apparatus into at least a score of different branches, there remains under the heading of "all other products," shown in Table 25, the large amount of $14,634,984. It is possible that some of this amount might have been separated and put under one of the categories dealt with above, but in each case reasons were considered which were deemed sufficient for non-inclusion. The public has probably very little idea of the vast range of the industry and its application, although in these modern times few efforts are spared to make it believe that electricity is a panacea for whatever ill or deficiency has not yet

TABLE 26.—AMOUNT RECEIVED FOR CUSTOM WORK AND REPAIRING: BY STATES, 1900.

STATES.	Value.	STATES.	Value.
United States	$2,063,736	Massachusetts	$108,936
		Michigan	83,216
California	97,633	Minnesota	29,060
Colorado	2,500	Missouri	15,365
Connecticut	4,075	Nebraska	7,000
Georgia	23,000	New Hampshire	8,663
Illinois	206,360	New Jersey	129,081
Indiana	86,504	New York	863,128
Iowa	7,490	Ohio	63,866
Kentucky	11,830	Pennsylvania	211,330
Louisiana	9,474	Rhode Island	20,340
Maine	12,269	Wisconsin	61,141
Maryland	1,475		

been cured or rectified in the advance of civilization. An idea of the miscellaneous character of the innumerable articles of an electrical nature now manufactured may be formed from the fact that a catalogue of a well-known supply house includes in its index over 2,000 separate articles, none of which belong in the category of large apparatus and all of which are embraced under the general head of "supplies." It is true that a great many of these articles would be included in the classes which have been discussed in this report, but there is a large residue, forming an extremely heterogeneous collection, best grouped as "all other products." As time advances, many of these crystallize into a new art, which, in turn, will demand treatment in later census work.

Old-Time Telegraphers in the West.

The twenty-second reunion of the Old-Time Telegraphers and Historical Association and the Society of the U. S. Military Telegraph Corps was held at the Kenyon Hotel, Salt Lake City, September 10, 11 and 12. About 200 members with their wives and daughters were in attendance, and enjoyed the sights in and around the city during their stay. Some of the Eastern delegates extended their trip and are making excursions to the far West and California.

At the business meeting, held at the Kenyon, Wednesday forenoon, President G. H. Corse was in the chair, and was decorated with a beautiful medallion, on which was carved the face of Prof. Morse, the father of telegraphy. An address of welcome was delivered by Rev. W. Simpkins, to which fitting response was made by Mr. Cochrane, of Milwaukee.

The report of Secretary-Treasurer John Brant showed a membership of over 1,000, with a large list of applicants for membership. The age limit for admission was raised to 25 years, with an additional five years of actual prior service. This action was deemed necessary in order to keep the membership down to reasonable limits. Many of the present "old-timers" are comparatively young men.

Milwaukee was selected as the next meeting place for the reunion in September, 1903. Thursday evening a banquet was given at the Kenyon, and delightful reminiscences, toasts and stories, witty and pathetic, of experiences dating back to the days of '49, kept the large assembly in good humor until another day had dawned.

The meeting of the U. S. Military Telegraph Corps consumed but a few minutes, as no business of importance was transacted. The visitors expressed their delight and satisfaction with the hospitality of the City of Zion, and departed highly pleased after having enjoyed a delightful season among the easy-going dwellers in the picturesque Mormon capital.

Convention of the Association of Edison Illuminating Companies.

The twenty-third convention of the Association of Edison Illuminating Companies was held last week at the Mount Washington, White Mountains, N. H. The proceedings began on Tuesday, Sept. 9, with an address by the president, Mr. Louis A. Ferguson, of Chicago. In the course of his remarks, Mr. Ferguson paid a deserved compliment to the work done by the various standing committees, particularly the lamp and meter committees, and also the storage battery committee, which was appointed last year for the first time. He advocated an extension of the work done by the appointment of additional standing committees to collect data and formulate opinions for the use of the members of the Association. Among these should be standing committees on other kinds of illumination which compete with electricity; on steam turbines; on rates; on relations with kindred societies and associations; and on theft of current. He spoke strongly on the importance of devoting more time than had hitherto been spent upon mechanical and theoretical problems which arose in connection with the problems of the electrical art. He also referred to the proposed action of the National Board of Fire Underwriters in reference to high potential currents, and urged upon the members the importance of giving their closest attention to the proposed changes in the rules of the National Board so that the electrical industry would not be prejudiced thereby.

In submitting the report of the committee on higher potential conductors, the chairman, Mr. J. W. Lieb, Jr., of New York, spoke of the proposed action of the National Board of Fire Underwriters in limiting the use of high potential conductors in the vicinity of buildings, and of the desire of the various representative electrical bodies to secure harmonious co-operation with the national board of fire underwriters without sacrificing the interests of the electrical industry. In conclusion Mr. Lieb proposed that the name of the committee should be changed to that of the committee on the National Code in order more clearly to define its functions.

The sessions of the convention were held each morning from 9:30 to 1:00, and each evening from 8:00 until 10:30. This allowed the whole of the afternoon for excursions and for golf playing. On Tuesday a large party of ladies and members drove to the base of Mount Washington. On Wednesday no formal program was set, but in the afternoon a large party walked to the Upper Falls of the Ammonoosuc and thence through the woods to the new road, returning to the Mount Washington. On Thursday two golf tournaments took place, one for the ladies, and one for the members. The ladies' tournament occupied the forenoon. Two trophies were presented as prizes by Mr. Louis A. Ferguson, the president of the Association. The first was a handsome pitcher of Bohemian glass with a beautiful design of deposited silver. The second prize was a flask of similar material. These prizes, which were awarded for the lowest net score, were won by Mrs. Walter C. Fish, of Lynn, and Mrs. Alexander Dow, of Detroit. The members' tournament took place the same afternoon, the prizes for which were presented by the Boston Edison Company, consisting of a handsome oxidized silver tankard and an oxidized silver pitcher. The first prize in this contest was won by Mr. L. K. Edgar, of Boston, and for the second prize Mr. H. W. Hillman and Mr. W. L. R. Emmet, both of Schenectady, were tied. In the evening there was a ping pong tournament, for which prizes were presented by Mrs. C. L. Edgar, of Boston. The winner of the first prize was Mrs. W. C. Fish, of Lynn, and of the second, Miss Duclos, of Boston. The convention adjourned early in order to allow the members to join in an informal dance, which lasted until midnight. There was also a fine water polo tournament in the hotel swimming pool, under the management of Mr. Walter H. Johnson, who also participated.

The General Electric Company acted as host on Friday, and invited the members of the Association, and those who accompanied them, to luncheon at the Summit House, Mt. Washington. About one hundred and thirty members and ladies accepted this invitation and were taken up on the Mt. Washington railway on specially reserved cars. After luncheon about fifty members of the party took the stage to Glen Station, while some thirty others walked across the mountains to the Crawford House, the remainder returning by train.

This ended the most largely attended convention which the Edison Association has ever held, and one of the most enjoyable not only in regard to the scenery and the perfection of the hotel accommodations, but also in regard to the fine weather which prevailed during the sessions of the convention.

Over 20 papers were read before the convention. Of those presented in printed form, we give abstracts of two elsewhere in the issue, namely, one by Dr. Clayton H. Sharp on checking electrical instruments, and another, by Mr. Geo. H. Lukes, on high-tension work in the Far West.

Mr. H. G. Stott read a paper, entitled "Steam-Pipe Covering and Its Relation to Station Economy," in which an account is given in detail of tests made by the Manhattan Railway Company on a number of kinds of steam-pipe covering. A paper, by Mr. W. S. Andrews, had for its subject, "Automatic Voltage Regulators," which were described under the heads of automatic regulators and feeder regulators. "Coal Deposits of the United States" was the title of a paper read by Mr. W. L. Abbott, which included maps of the various coal regions of the country and several charts, one of these latter giving a sectional view through the coal basins of Iowa, Illinois, Indiana, Ohio and Pennsylvania, and another, a section through an anthracite bed. A compilation of great interest was presented by Mr. F. W. Wells, giving the principal dimensions and data of the five great New York power stations, which were illustrated by sections and plans. "Curves Showing the Available Capacity of a Lead Accumulator" was the title of a paper by Mr. Ernest Lunn, in which instructions are given for the laying down of curves, by means of which it may be determined at short length how long a certain rate of discharge can be carried on a given battery. Abstracts of the above and some of the other papers read will be given in future issues.

LIST OF ATTENDANTS.

GENERAL ELECTRIC COMPANY.—C. A. Coffin, Elihu Thomson, W. S. Andrews, W. L. R. Emmet, C. B. Davis, F. P. Cox, C. T. Hughes, J. W. Howell, R. Fleming, E. H. Mullin, H. J. Buddy, J. R. Lovejoy, G. F. Morrison, F. W. Willcox, P. D. Wagoner, B. E. Sunny, A. L. Rohrer, W. C. Fish, E. E. Gilbert, C. D. Haskins, H. W. Hillman, F. M. Kimball.

NEW YORK EDISON COMPANY.—T. E. Murray, J. W. Lieb, Jr., A. Williams, P. Torchio, H. M. Edwards, A. H. Ackerman, T. W. Varley.

CHICAGO EDISON COMPANY.—S. Insull, L. A. Ferguson, W. M. Anthony, O. J. Bushnell, W. G. Carlton, J. F. Gilchrist, P. Junkersfeld, R. C. P. Holmes.

BROOKLYN EDISON COMPANY.—W. W. Freeman.

DETROIT EDISON COMPANY.—A. Dow, H. Post, G. W. Cato.

PHILADELPHIA EDISON COMPANY.—A. J. De Camp, W. H. Johnson, J. T. Maxwell, J. D. Israel, G. R. Green, W. C. L. Eglin.

BOSTON EDISON COMPANY.—C. L. Edgar, H. S. Kimball, A. S. Knight, R. S. Hale, G. Goettling, C. H. Parker, H. A. Wagner, L. L. Elden.

COMMONWEALTH ELECTRIC COMPANY, Chicago.—L. Stieringer.

U. S. ELECTRIC LIGHT COMPANY, Washington.—G. H. Harries, L. E. Sinclair.

CLEVELAND ELECTRIC ILLUMINATING COMPANY, Cleveland.—M. E. Turner, R. Lindsay.

DES MOINES (IA.) EDISON COMPANY.—R. H. MacMullan.

ROCHESTER (N. Y.) GAS AND ELECTRIC COMPANY.—G. A. Redman.

ATLANTA (GA.) EDISON COMPANY.—J. G. Roseman.

EDISON COMPANY OF ERIE, PA.—T. G. O'Dea.

NEWPORT (R. I.) ILLUMINATING COMPANY.—G. P. Magner.

MANHATTAN RAILWAY CO., N. Y.—H. G. Stott, Cons. Engr. Buffalo General Electric Company.

NEW BEDFORD (MASS.) EDISON COMPANY.—G. R. Stetson, G. R. Price.

ALTOONA (PA.) EDISON COMPANY.—E. B. Greene.

COLUMBUS (O.) EDISON COMPANY.—A. W. Field.

WASHINGTON WATER POWER COMPANY, Spokane, Wash.—D. L. Huntington.

CHATTANOOGA (TENN.) LIGHT AND POWER COMPANY.—B. T. Burt.

TOLEDO (O.) RAILWAY AND LIGHT COMPANY.—E. J. Bechtel.

WILLIAMSPORT (PA.) EDISON COMPANY.—E. H. Davis.

INDIANAPOLIS (IND.) LIGHT AND POWER COMPANY.—C. C. Perry.

The following were also present: C. H. Sharp, Lamp Testing

Bureau, N. Y.; F. E. Barker, chairman Mass. Gas and Electric Light Company; T. C. Martin, editor ELECTRICAL WORLD AND ENGINEER; S. Douglas; T. E. Crossman, official stenographer; W. S. Barstow, consulting engineer; C. W. Rice, vice-president, and Mr. Beebe, chemist, Nernst Lamp Company; T. E. Hughes, Standard Underground Cable Company.

The following ladies were also present: Mrs. Thomas E. Murray, Mrs. John W. Howell, Mrs. Frank W. Lund, Mrs. C. A. Coffin, Miss Coffin, Miss Alice S. Coffin, Mrs. Samuel Insull, Miss Bird, Mrs. L. E. Sinclaire, Mrs. A. L. Rohrer, Mrs. J. T. Maxwell, Mrs. W. S. Andrews, Mrs. E. Marden, Mrs. E. B. Greene, Mrs. Charles T. Hughes, Mrs. H. W. Hillman, Mrs. Alex. Dow, Mrs. J. F. Gilchrist, Mrs. Hoyt Post, Mrs. C. B. Davis, Mrs. F. W. Wilcox, Mrs. R. Fleming, Mrs. C. R. Price ,Mrs. George R. Stetson, Mrs. H. C. Wirt, Mrs. L. L. Elden, Mrs. C. D. Haskins, Mrs. F. T. Cox, Mrs. T. E. Hughes, Mrs. C. C. Perry, Mrs. H. M. Edwards, Mrs. J. W. Lieb, Jr. Mrs. W. W. Freeman, Mrs. C. L. Edgar, Mrs. W. S. Barstow, Miss Duclos, Mrs. A. S. Knight, Miss Howell, Mrs. J. R. Lovejoy, Mrs. Fred. M. Kimball, Miss N. L. Kimball, Mrs. B. E. Sunny, Miss Sunny, Mrs. Louis A. Ferguson, Mrs. Philip Torchio, Miss Eglin, Mrs. A. J. De Camp, Miss De Camp, Mrs. W. H. Johnson, Miss Huntington, Mrs. E. H. Mullin.

Checking Electrical Instruments.*

BY DR. CLAYTON H. SHARP.

Undoubtedly the best arrangement for checking a voltmeter as well as for the accurate measurement of steady direct-current potentials in general, is the potentiometer, used with a standard cell. In central stations only a few voltages need be cared for, and a potentiometer suitable for reading only a few voltages can be made very simple in construction and in operation. Such a potentiometer may be used in connection with a voltmeter to keep all the pressure employed in the station checked up. The scale of the voltmeter should be calibrated once for all so that the variation of its correction at all required points is known, after which a determination of the absolute value of its correction at one or two points suffices to give its correction at all points.

A diagram of the circuits of a simple potentiometer intended to measure only one definite voltage is given in Fig. 1. The voltage to be measured is brought to the binding-posts, *A* and *B*, which are connected by coils of high resistance—100,000 ohms or higher. From a suitable point, *D*, of the coils a tap is brought out to the binding-posts D^1. *D* is so chosen that the resistance *AD* bears the same ratio to the resistance *AB*, as does the e. m. f. of the standard cell to the e. m. f. to be measured.

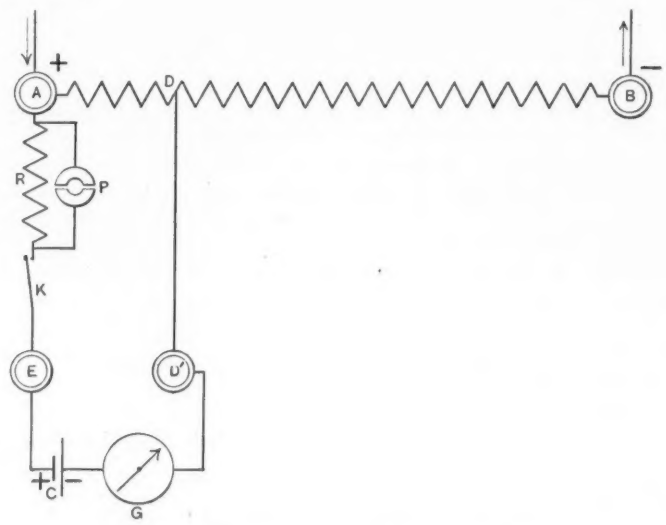


FIG. 1.—DIAGRAM OF SIMPLE POTENTIOMETER.

The standard cell, *C*, is connected to *A* through the binding-post, *E*, and the key *K*, and is connected to D^1 through the galvanometer, *G*, and the high resistance, *R*. The latter is intended for the protection of the cell against anything approaching a short-circuit, and may be itself short-circuited at *P* when the potentiometer has been nearly balanced. If *A* is connected to the positive side of the circuit, the positive terminal of *C* is connected to *E*, and *vice versa*.

* An abstract of a paper read at the Mt. Washington Convention of the Edison Illuminating Companies.

If connections are made as described, when the proper e. m. f. is applied to *AB*, and the key *K* is depressed, the galvanometer shows no deflection. If on depressing the key a deflection is noted, the e. m. f. on *AB* must be adjusted until the deflection is reduced to zero. If a voltmeter is connected in multiple with *AB*, and a reading of it is taken at the time the above adjustment is secured, the value of its correction is obtained at once.

If it is desired to arrange the potentiometer to read more than one voltage, more taps similar to DD^1 are added. It is an advantageous arrangement to have the potentiometer read three or more voltages, which are multiples of each other, such as 58, 116 and 232. These voltages cover the principle ranges for incandescent lamps. Now, if two cells which agree with each other in the indication of any one voltage are connected in series on the 58-volt point, they should give the same indication as does one cell alone on the 118-volt point. Thus the accuracy of the potentiometer can be partially checked.

The Clark standard cell has a large temperature coefficient, the variation of its e. m. f. amounting to nearly 0.1 per cent. per degree centigrade. It is, consequently, necessary in using a potentiometer with this cell either to apply a correction to its indications corresponding to the temperature of the cell, as can readily be done from a table of corrections, or to construct the potentiometer so that these variations can be compensated for.

A diagram of a three-point potentiometer with compensation for temperature is shown in Fig. 2. Here a series of taps is brought out

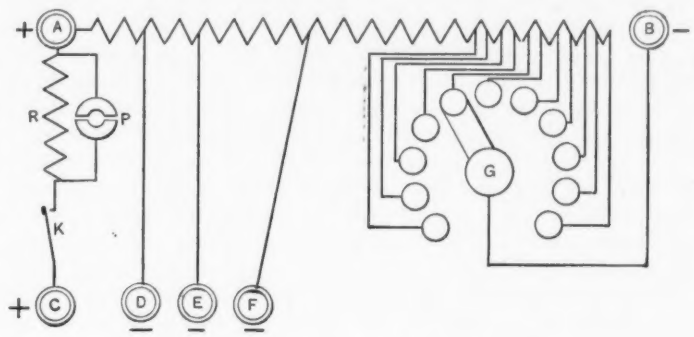


FIG. 2.—DIAGRAM OF THREE-POINT POTENTIOMETER.

from the resistance *AB* to contact studs over which a switch contact, *G*, sweeps. Each of the studs is marked with the temperature of the Clark cell to which it corresponds, hence in making measurements it is necessary only to set *G* on the proper stud to get results which need no correction for cell temperature.

This potentiometer may be further extended to make it a self-contained, portable instrument. To this end a pivoted galvanometer of the moving coil type, of high resistance and strongly damped, together with three portable standard cells, are inclosed in the same box with the resistance coils. When this is done, outside posts should be provided for connecting the cells either singly or in series, and for using, if desired, an outside cell and galvanometer.

A portable three-point potentiometer of this type has been in use by the Lamp Testing Bureau for some time, and has given very satisfactory results. The sensitiveness of the little galvanometer is such that voltages can be read to 0.1 per cent. It possesses among other merits that of great simplicity in construction and use, consequently it requires no especial skill to operate it. Any person who can read a voltmeter accurately, can be taught in a short time to use the potentiometer. The calibration of the voltmeter throughout its scale can, of course, be done only by using a regular potentiometer or its equivalent.

Dr. Sharp discussed the Clark and cadmium standard cells, and expressed the opinion that the latter is more convenient to use than the Clark cell.

To secure the utmost reliability in the indications of a standard cell, certain simple precautions need to be taken. The most important thing is to avoid drawing any appreciable current from it. A current passing causes polarization in the cell and diminishes its e. m. f. If, by accident, a cell has become polarized by being short-circuited, its usefulness is by no means at an end, since if it is properly constructed it will come back to its normal e. m. f. in the course of a few hours or days. The potentiometer method, being a zero method, makes no demands on the cell for current when once a balance has been secured. Until such a balance has been nearly secured, a high resistance should be included in the cell circuit.

For absolute certainty, it is advisable to have three or more cells.

which are checked against each other. If three cells which are known to have been accurate, and found at any time to be in substantial agreement, that is, if they do not differ from each other by more than a few ten-thousandths of a volt, it is almost certain that they are right. It is better to use only such cells as have been compared with standards of known accuracy. The e. m. f. of such cells may be relied upon as being within a few hundredths of 1 per cent. of its nominal value. The adjustment of the resistance in the construction of the potentiometer can be carried out to a similar degree of accuracy, which becomes consequently the measure of the accuracy attainable with the potentiometer method.

The best way to measure current strength accurately is (if we leave the silver voltameter out of account) by finding the potential difference between the terminals of a conductor of known resistance, through which the current flows. Suitable conductors for this purpose are made of manganin, an alloy which has a very low temperature coefficient, of a resistance as low as one-ten-thousandth of an ohm, and calculated to carry as much as 2,000 amperes without undue heating. The measurement of the potential difference must be made with a complete potentiometer.

A modification of this method, which is very suitable for checking ammeters consists in the substitution for manganin low resistance standards, high resistance standards in the form of incandescent lamps. These lamps are standardized, not by determining their resistance, but by measuring very carefully their current consumption at a given voltage or series of voltages, using the standard resistance and potentiometer, or any other good method of current measurement. Good lamps should be selected for this purpose, and these should be carefully and cautiously seasoned to the point, that they can be relied upon to change only very slowly with age. To secure durability, the temperature at which they are operated should not be higher than that corresponding to four watts per candle, but it should not be so low that the resistance of the filament is appreciably influenced by changes in room temperature. They should be standardized for current consumption at a voltage which the station potentiometer indicates.

Lamps which are so prepared and which are never subjected to a voltage higher than that for which they are standardized, constitute very permanent and reliable standards of as high accuracy as may be desired. A series of such lamps may be selected which when operated in multiple in various combinations, will cover a wide range of current values with very small steps from one value to the next. The accompanying table gives a series of ampere lamps in the possession of Lamp Testing Bureau:

Series of Ampere Lamps.

Amperes at 116 Volts.	Amperes at 116 Volts.
0.0519	1.005
0.0515	0.924
0.1008	2.093
0.1181	2.070
0.215	3.430
0.191	3.483
0.506	
0.499	

It is quite probable that by sampling a larger variety of lamps, a nearer approach to the theoretical series could be obtained, but it is doubtful if any gain would result. A lamp with higher current consumption than 3.5 amperes would, however, be useful.

Alternating-current voltmeters can best be checked by comparing them with a standardized direct-current voltmeter through the medium of an inductionless transfer instrument. Probably the best transfer instrument is an electrostatic voltmeter, although a hot-wire voltmeter, the series resistance of which has been wound to avoid inductance and capacity, can be used with good results.

The hot-wire voltmeter is especially sensitive one, constructed by the Stanley Electric Manufacturing Company, one-tenth of a volt being easily readable on its scale. This voltmeter is calibrated by bringing it in multiple with a Weston laboratory standard direct-current voltmeter, which has been checked by a three-point potentiometer. The pressure is adjusted to the point at which a check is desired, and the error of the hot-wire voltmeter is determined. The alternating-current pressure is at once thrown on to the hot-wire instrument and the check is obtained. For greater security the direct-current readings may be remade after the alternating-current measurements.

With seady pressures, both alternating current and direct current, quite a close check can be obtained in this way. On account of its high sensitiveness, the range of this instrument is small, from 110 to 120 volts only. The resistance in series with the wire seems not to be entirely free from reactance, as the indications are from 0.05 to 0.1 volt lower than the reactanceless electrostatic instrument gives.

The other transfer instrument referred to is a Kelvin multicellular electrostatic voltmeter of the vertical scale type, of 60 to 140 volt range, fitted specially with a mirror attached to the moving part so that delections can be read with the aid of a telescope and scale, or of a lamp and scale.

The torsion-head of the instrument is adjusted so that its indications come on the scale at the voltage to be measured, and deflections on direct current are obtained. The leads to the electrostatic instrument must be reversed in this test, and the mean of the direct and reversed deflections taken. This is on account of a small contact e. m. f. existing in the instrument itself.

The alternating-current pressure is then applied, and the deflection is again noted. To evaluate in volts the difference between the alternating-current and direct-current pressures, as measured in scale divisions, a near-by direct-current voltage is measured, and the number of scale divisions per volt is determined. The value of this quantity will vary somewhat with the angle of deflection, but in all cases it is sufficiently large. In the instrument referred to, a deflection of about 6 cm. per volt, at 116 volts, with the scale about one meter distant, is obtained. One-tenth of a volt corresponds then to six small scale divisions.

By adjusting the torsion-head of the instrument, it may be used for checking voltages in the 50-volt range, or in the 220-volt range. By using a volt-box multiplier, the range may be extended upward almost indefinitely. The sensitiveness of the instrument at a given angle of deflection is proportional to the voltage.

A check can easily be made in this way to 0.1 volt on steady pressures. With unsteady pressures a good comparison is much more difficult to obtain, since the Kelvin instrument is very sluggish in its movements, due to oil damping and to the very small moving force. For rough checks, such as alone are necessary when the pressure is unsteady, the telescope and scale may be dispensed with, and comparisons made by reading the pointer of the instrument directly. This type of transfer instrument has the very great advantage of being entirely free from reactance.

For the calibration of alternating-current ammeters not belonging to the types, such as the Kelvin balance, the Siemens electrodynamometer, hot-wire instruments, etc., which are themselves reliable direct-current—alternating-current transfer instruments, the series of ampere lamps used with an alternating-current voltmeter, calibrated at one point, as indicated above, serve admirably well. Practically all that has been said about these lamps in connection with direct-current work, applies equally well to them used on alternating-current.

Having voltmeters and ammeters calibrated by the methods indicated above, the calibration of direct-current wattmeters and of alternating-current wattmeters on power-factor unity, can be made from them. Incandescent lamps standardized for watts instead of for amperes, are useful in wattmeter calibration, rendering the use of a calibrated ammeter unnecessary. A set of lamps can serve both as ampere standards and as watt standards.

American Electrochemical Society.

At a meeting of the Board of Directors of the American Electrochemical Society, held at the Society's headquarters, in Philadelphia, September 4, the following new members were elected: Prof. Dr. Nicolas Piltschikoff, University of Kharkov, Kharkov, Russia; Prof. Dr. Richard Lorenz, Zurich, Switzerland; Dr. Henry T. Boettinger, president German Electrochemical Society (Deutsche Bunsen Gesellschaft), Elberfeld, Germany; J. A. Capp, Schenectady, N. Y.; Stanislaus P. Franchot, Niagara Falls, N. Y.; Walter B. Bishop, Grand Forks, B. C.; Charles B. Borton, Berlin, N. H.; Wyatt Hamilton Allen, San Francisco, Calif.; Robert Anton Fliess, East Orange, N. J.; Sol. D. Benoliel, Niagara Falls, N. Y.; Aldus C. Higgins, Worcester, Mass.; F. M. Perkin, Forest Hill, London, Eng.; George N. Jeppson, Worcester, Mass.; Robert T. Frazier, Washington, D. C.; Oliver P. Fritschle, Denver, Colo.

Construction of Transmission Lines.

At the recent convention of the Edison Illuminating Companies Mr. Geo. H. Lukes read a paper, entitled "High-Tension Work in the Far West," which after considering the conditions that have led to the great development of high-tension work on the Pacific Slope, treats at length of the construction of transmission lines. This portion of the paper we reproduce below, in full, together with that part treating of switching, regulation and rates:

The poles commonly in use on the newest transmission lines are either of square sawed redwood, tapered from butt to top, or Oregon or Washington cedar. The Oregon cedar poles used by the Bay Counties Company in its lines from Colgate to Oakland, a distance of 142 miles, are painted with hot tar from the top of the pole to a point six inches below the bottom cross arm. The butts are saturated with hot carbolineum for three and one-half feet where the pole enters the ground. The following table gives data on the poles:

Height.	Top.	Butt.	Depth in Ground.
40 Ft.	9x9″	14x14″	6 Ft.
45 Ft.	10x10	15x15	6 Ft. 6″
50 Ft.	12x12	16x16	7 Ft. 6″
60 Ft.	12x12	18x18	8 Ft.

The redwood poles are from the hearts of young trees, not more than four poles being taken from one tree, and being free from sap when set, they will last from 25 to 35 years. The following table gives the dimensions and other data on the redwood poles used by the Standard Electric Company on the transmission line from their power house at Electra to San Francisco:

Height.	Top.	Butt.	Depth in Ground.
35 Ft.	7x7″	12x12″	5 Ft. 6″
40 Ft.	8x8	13½x13½	6 Ft.
45 Ft.	9x9	15x15	6 Ft. 6″
50 Ft.	10x10	16x16	7 Ft.
60 Ft.	11x11	17x17	8 Ft.

The cross arms are made of selected kiln-dried Oregon pine 6 x 6 inches square, and an overall length depending on the distance between wires. After passing through the dry-kiln they are placed in an enclosed boiler containing asphaltum oil, and subjected to a temperature of 220° F. for several hours. This preserves the wood, and at the same time increases the insulation of the pole top. The arms are gained into the pole a distance of one inch and are held in position by two ⅝-inch through bolts with cast-iron washers three inches in diameter under both head and nut. The cross arms are surfaced all round and crowned on top to shed the water. The insulator pins are of oak, locust, or eucalyptus wood. The latter wood is universally used on the Coast on account of its immunity from attack by worms and bugs, even the deadly teredo not touching it. The eucalyptus pins are treated in the following manner: The timber is sawed into sticks three inches square and placed in boiling water for 24 hours. After being air dried for several months, it is worked up into pins. The pins are then placed in a vat of boiled linseed oil, and kept at a temperature of 210° F. for several hours. The pins are 16⅞ inches long over all, and the diameter at the lowest shoulder is 2¾ inches. They are driven into the cross arm with special care, a hardwood pin-set being used. The pin holes in the arm are 2¼ inches in diameter and 5 inches deep, leaving one inch of solid wood below the pin. On each side of the pin, at a distance of 3 inches from the pin and 2 inches from the top of the cross arm, ½-inch carriage bolts are placed, in order to prevent the arm from splitting when unusual strains are thrown on the pins. That this accomplished the purpose is shown by the result of a series of tests made by the Standard Electric Company, in which the cross arm was split without the bolts with a pull on the thread of the pin of 1,200 pounds, whereas with the bolts in position, the pin broke at the shoulder with a pull of 2,200 pounds, thus almost doubling the strength of the arm.

One very noticeable feature of the pole-line construction is the absence of guy wires. On account of the high voltage, the ordinary strain insulator is of no use, and the common practice is to use wooden struts. These are 6 x 6-inch timbers, fastened to a deadman, buried 5 feet in the ground, and bolted through the pole at the cross arm. Sometimes when a guy cannot be avoided the strut is used as an anchor, or if a guy is used, a 6 x 6-inch timber, 20 feet long, is inserted in the guy as a strain insulator. The poles are usually set about 130 feet apart, and whenever a small angle is made in the line two poles are placed close together, in order to divide the strain. On all angles double arms are used, and double cap pieces bound with wrought-iron bands support the top wire. In single construction, the pole-pin is usually driven into the top of the pole, and a wrought-iron band driven down onto the pole to keep it from splitting. In some cases a bracket pin, 3 feet long and 4 x 4 inches in section, is bolted through the pole.

As an illustration of scientific methods applied to pole-line construction, the line is staked out by a surveyor, the poles are set with a plumb-bob, and the foreman of construction carries a thermometer and a set of curves, from which he fixes the proper sag to give to the wires. The wires are placed at the points of an equilateral triangle. The wires are from 36 to 42 inches apart, and are spiralled, one-third of a twist being made every mile. The Telluride line, in Utah, is unique in that no iron was used in the construction. The cross arms are mortised through the poles, and wooden pins are used instead of bolts. Wooden cross arm braces are fastened to the poles, and cross arms with wooden pins. The object of all this is to increase the insulation of the pole head, but it is open to the criticism that it is mechanically weak.

The insulator is, without doubt, the most important part of the line. As long as the voltage did not exceed 20,000, and the wires to be supported were of small size, the problem of providing a satisfactory insulator was comparatively easy. When 150-mile lines, transmitting 10,000 hp at 40,000 volts over aluminum cables ⅞-inch in diameter were designed, great difficulty was experienced in finding an insulator that was both electrically and mechanically strong. The insulator in common use for this purpose is of the two-part type, the upper petticoat being of porcelain, and the lower part of glass cemented into the porcelain. The upper petticoat is nearly flat, and is provided with a rim and spout to drain the water clear of the cross arm. The lower petticoat is shaped like a truncated cone, and protects the pin. This insulator measures 11 inches in diameter across the top petticoat, and is 11 inches in height. When in position on the arm, the wire is 15 inches above the cross arm. There is much difference in opinion among power transmission engineers on the insulator question. Some condemn glass and others porcelain. Some insulators are strong mechanically and weak electrically, and others are just the opposite. The difference in opinion is probably due to the different nature of the troubles encountered. For instance, the engineers of one company were very much surprised to find that their insulators gave less trouble in wet weather than in dry. As soon as the fall rains began the insulator trouble ceased. An investigation showed that where the lines ran near railroad tracks the insulators got very dirty and insects of various kinds lodged under the petticoats. This decreased the striking distance, and the insulators broke down. The remedy applied in this case was to shut down the line periodically and wash off the insulators. The general feeling among power transmission men is that no insulator in use at the present time would be safe to use on 60,000 volts. The large transmission companies intend to go up to 60,000 volts as soon as additional line capacity is needed, but as this means changing every insulator on their lines, at an expense of several hundred dollars per mile, they will delay action until they are reasonably sure that they have secured the proper insulator.

Aluminum wire has been used largely for transmission purposes on the Coast, with good results. The Standard Electric Company's line from Electra to Mission, San Jose, is aluminum cable of 37 strands, with a total cross-section of 471,034 circular mils. The weight per mile is 2,404 pounds, and its tensile strength is 28,000 pounds per square inch. Owing to the high coefficient of expansion of aluminum, care must be taken in stringing the wires to allow sag enough so that the wire will not be too taut in cold weather. A peculiarity of aluminum wire, which makes its use in small sizes objectionable, is its low melting point. Aluminum melts at 1157° F., copper at 1929° F., and wrought-iron at about 2800° F. When an iron wire falls across an aluminum circuit and makes a short-circuit, the aluminum wire is melted through, and the iron wire remains intact. Thus the trouble is cleared from the circuit, but at the expense of opening the line. This peculiarity was taken advantage of a year or two ago in a substation supplied from a long-distance line at 30,000 volts. A short-circuit occurring on one of the distributing circuits, the switchboard attendant pulled an air break switch in the circuit. A tremendous arc resulted, which set fire to the substation. Not being able to reach the power house by telephone to have the line shut down, the substation was in imminent danger of being burned up. A quick-witted lineman, seeing the danger, threw a coil of iron wire over the aluminum transmission line outside of the station, and thus opened the circuit.

Transmission lines at these extremely high voltages are run as far as possible on private rights-of-way, from 50 to 300 feet in width.

In timbered country, the trees are cleared out far enough on each side of the line so that no trees in falling can cross the line. The lines are patrolled very carefully, each patrolman having a section 10 or 15 miles long. He reports frequently to the station over a private telephone circuit run on a cross arm about 5 feet below the power circuit. At intervals of two or three miles, taps are brought down from the telephone line to booths at the foot of the poles, and insulated stools are provided in the booths for the patrolman to use while connecting his portable telephone set. The telephone wires are transposed frequently to cut down the induction, and as a rule work fairly well as long as the load is in a balanced condition on the transmission line. When something, such as a short-circuit occurs, which unbalances the power line, the telephone line goes out of commission. As the telephone is most urgently needed at times of trouble on the power line, the value of a telephone line on the same set of poles with the power line is questionable. For the reason also that crosses occur between the power line and the telephone line, thus endangering life, the plan of removing the telephone wires from the transmission-pole line and installing on a separate pole line has been suggested more than once.

That pole lines are not absolutely reliable, and, moreover, are expensive to maintain, is shown by the fact that one company is seriously considering the plan of substituting a series of steel towers, about 90 feet in height and 1,000 feet apart, the wires to be suspended from tower to tower and separated about 9 feet. Although this construction will be more expensive than that of the ordinary pole line, it is thought that the decreased number of breakdowns and lower maintenance and depreciation charges would warrant the extra investment.

The construction of long-distance lines, using high voltages, for the purpose of supplying current to large lighting and railway companies, led to the use of duplicate transmission lines. At first two lines were installed on the same set of poles, but it was found that when trouble occurred on one line it was usually communicated to the other line, and so this practice has been abandoned and duplicate lines on separate pole lines are now considered necessary. Even with the introduction of duplicate pole lines, the situation is not entirely satisfactory on account of the short shut-downs caused by the difficulties in switching high-tension lines. The switches in ordinary use are of the air-brake type, and, while it has been claimed time and again that they can be opened safely under load, yet the fact remains that it is dangerous to do so, both on account of the surges set up in the transmission line and the arc at the switch, which is often disastrous. When one transmission line is held in reserve and trouble occurs on the line in use, it takes some little time to switch in the good line. When the two lines are run in multiple and a short-circuit occurs, the usual practice has been to either burn off the trouble or shut down the station and start up on the good line. If the short-circuit is serious and is burned off, the disturbance in frequency and voltage is usually sufficient to cause all synchronous apparatus at the end of the line to drop out of step. The same operating problem to a certain extent confronts the Eastern central station manager who contemplates the erection of a large station generating alternating current at high voltage, to be transmitted to substations and there converted into direct current. The Eastern man may avoid possible shut-downs by the use of time-limit, oil-switches and reverse-current relays, or he may, as a last resource, subdivide his station into several distinct parts, supplying separate lines, and use storage batteries as a reserve. In the West, oil-switches for voltages of 40,000 and over have not yet been developed; or, if they have, the price is prohibitive. Storage batteries can be used to a limited extent on direct-current and railway loads, but the high price has retarded their use.

The problem of securing good regulation on long lines has been a very troublesome one. Some of the difficulties due to inductive loads and charging currents have been overcome by the proper use of induction and synchronous motors combined with reactance coils connected across the circuit, but the facts remain that a railway load on the end of a long transmission line is a bad thing as far as regulation is concerned, and the time will come when the transmission companies will be forced to refuse railway business, unless storage batteries are installed to keep down the rapid fluctuations in load.

The transmission companies are wholesalers of electric current. They generate current, transmit it to the market, and sell it in large quantities to the local companies, reserving the right as a rule to sell current directly to large power consumers. The usual method of charging is by the horse-power per year. The rate varies from $18 to $90 per hp per year. The best price is obtained at points remote from railroads, where fuel must be hauled by wagon, such as at mines. The lowest price is obtained at cities on the water, where fuel is cheaper. Other methods of charging are in use in special cases. Current is sold to a street railway, for instance, on a car-mile basis; to a flour mill at so much per 100 barrels of flour turned out. In one case it is sold to a local company for a certain percentage of its gross receipts. It is needless to say that this local company is selling light in large quantities at flat rates, and is making money. Charging by the horse-power year method is supposed to be logical for water-power plants, because the operating expense does not vary with the load. Nevertheless, the method has all the objections that apply to any flat-rate system. It encourages waste and demoralizes rates. As long as the local companies can buy current on the horse-power year basis, they will sell light at flat rates. It is not impossible that the method of charging will have to be changed at some future time, for the following reasons: The water supply in this country is not unlimited. Already some of the companies find it necessary to provide storage to carry them through the dry season. As each company approaches the limit of hydraulic development, it begins to cast about for some means of increasing its capacity. Some companies have found it practical to construct storage reservoirs at the heads of their pipe lines. During the hours of small load, the water runs from the flume into this reservoir, and when the peak comes on the reservoir is discharged into the pipe line, and thus helps to take care of the peak. When this point is reached by any company it is evident that any method of charging which reduces the waste, even at the hours of small load, becomes highly desirable, and so it seems quite likely that in the course of time it will be necessary to get on some sort of maximum-demand basis.

The future of long-distance, high-voltage transmission in the West depends largely upon the development of oil as a fuel. If the production of the oil fields continues to increase so that oil entirely displaces coal as a fuel in certain sections of the country, it is evident that the price of fuel will be so lowered that the transmission plant will be unable to compete with local plants using oil as fuel. On the other hand, in certain sections, fuel will always be high, on account of high cost of transportation. It is in these localities that the power transmission companies will find their best field for growth.

Nickel-in-the-Slot Attachments for Telephones.

Whether a subscriber for a Kinloch telephone has a right to use a nickel-in-the-slot attachment, rented from an outside corporation, is a question which the courts probably will have to decide. A test suit will be instituted by Will E. Berryman, a St. Louis druggist, against the Kinloch Company. Mr. Berryman insisted upon using the coin attachment, which the telephone company objected to. He has paid his subscription in advance, and, therefore, the instrument was not taken out. The service, however, has been discontinued.

Several weeks ago the Druggists' Association and later the Retail Butchers' Association decided that free Kinloch telephones were becoming a nuisance. The privilege, they declared, was being abused, particularly by young men and women, who were in the habit of coming in and indulging in long conversations. The Controller Company of America was then organized to exploit a patent attachment.

It is stated that about seventy-five controllers have been put into use by the subscribers of Kinloch telephones for their own protection. The nickel-in-the-slot box is not placed upon the telephone, but upon the wall. It has an extension lever which projects over the receiver hook. When a coin is dropped in the box this lever is released and a person is enabled to get a connection.

The Controller Company claims that a subscriber has a right to lock up his telephone if he wants to, and this is what the controller does. It, therefore, becomes the subscriber's business. He has it placed near the instrument, not upon it, and the telephone is locked in a convenient manner. By an outsider it is unlocked with 5 cents.

It is stated that the Kinloch Telephone Company had caused more than fifty of its subscribers to discard the use of the controllers, because they were interfering with the service. It is also said that many of the subscribers who have paid their subscriptions have been cut out. The Kinloch Company, it is stated, intends to reserve the right to attach coin collecting devices to its instruments.

Underground Work for Telephone Exchanges—IV.

BY ARTHUR V. ABBOTT, C. E.

The square duct presents the advantage of requiring a minimum expenditure of mortar in the construction of the subway, while the smooth surface requires this shape to depend for solidity on the actual adhesion of the mortar to the exterior of the vitrified clay. In the case of the round pipe, a maximum amount of concrete or mortar must be employed in order to fill all the voids between different ducts. Here again solidity depends upon actual adhesion, but with the round pipe, each duct lies in a matrix of concrete, in precisely the same manner as with wrought-iron pipe or cement-lined pipe ducts. The hexagonal form offers a compromise between the round pipe and the square brick, while the fluted pipe is designed to secure a maximum strength by allowing the cementing material to imbed itself in the corrugations molded upon the sides. The American Vitrified Company score good points in supplying their single duct material with socket joints, so that the successive lengths may fit into each other, thus securing a much better joint than can ever be obtained with simply butted ends. Each piece of the square type is provided with a dowel-pin hole in each corner, so, if desired, four dowels may be used at each joint, thus insuring the best possible centering of every piece.

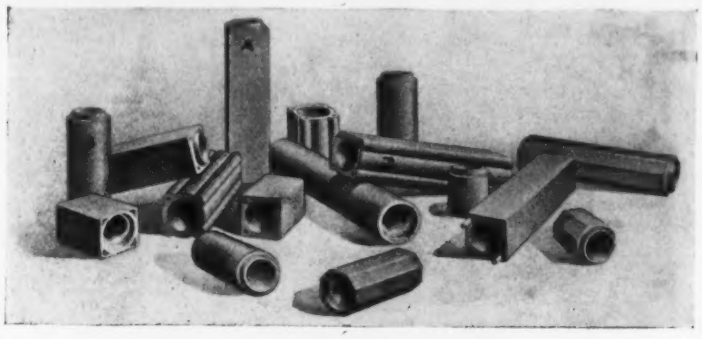


FIG. 21.—TYPES OF SINGLE-DUCT CONDUIT.

Fig. 23 illustrates the general design of multiple duct form which may be obtained with any number of cable spaces from 2 to 16, and with this wide selection, it must be a very exacting designer who cannot pick such a form of duct material as will best suit the particular needs of the work in hand. In Fig. 22 the latest form of so-called "Round Hole Multiple Duct" is shown. This type is a kind of compromise between the hollow brick and the regular multiple duct system.

The following table, No. 7, recites the general sizes of the various forms of duct material thus obtainable:

TABLE 7.—CONDUIT SIZES.

THREE-INCH DUCTS.

Type of Conduit.	*Size of End Section in inches.*	*Standard Lengths in inches.*	*Special Short Lengths in inches.*	*Approximate Weight per Duct Foot.*
Single dowel	4¼ x 4¼	18	6 & 12	10 lbs
Square, self-centering.	5 x 5	18	6 & 12	14 "
Round, self-centering.	4⅞ dia.	18	6 & 12	10 "
Octagon, self-centering	4⅞ dia.	18	6 & 12	10 "
Two-duct	4⅜ x 8¾	24	6 & 12	8¾ "
Three-duct	4⅝ x 13	24	6 & 12	8½ "
Four-duct	4¾ x 8¾	36 & 48 & 72	6, 9 & 12	8 "
Four-duct	4¾ x 17	24	6 & 12	8 "
Six-duct	8¾ x 13	36 & 48 & 72	6, 9 & 12	8 "
Nine-duct	13 x 13	36	6, 9 & 12	7¼ "
Twelve-duct	13 x 17	30	6, 9 & 12	7¼ "
Sixteen	17 x 17	30	6, 9 & 12	7¼ "

TWO-INCH DUCTS.

Type of Conduit	*Size of End Section in inches.*	*Standard Lengths in inches.*	*Special Short Lengths in inches.*	*Weight per Duct Foot.*
Six-duct	6 x 9	36	.....	4½ lbs.
Nine-duct	6 x 9	36	.....	4¼ "

In Fig. 24 a series of diagrams are given, showing in detail the way in which multiple ducts of various capacities may be grouped in order to obtain a subway of any desired number of ducts from 2 to 72. These diagrams are based upon the use of a 4-in. concrete foundation for the conduit, with a 3-in. cover, but with no concrete upon the sides. The bottom foundation is essential to life and durability. The top cover is of use to prevent injury to the conduit from careless street excavations, and is only desirable for this purpose. The concrete at the sides serves a similar purpose only, and both the sides and top may be omitted if the economy thus obtained is considered equal to the risks incurred of injury to the subway, but there is no question that the complete concrete encasement gives the strongest, most substantial and securest structure, and is, by the best opinion, considered fully worth its cost.

The method of laying both the single and multiple ducts have been already so fully described, that it is only necessary to refer to Fig. 25, showing the construction of a 34-duct subway of single-duct material, and Fig. 26, the construction of a 48-duct subway using four 9-duct sections and two 6-duct sections. In both cases the duct material is placed upon its concrete foundation, the trench is sheeted with timber, allowing three inches on each side for the concrete encasement. In Fig. 25 the cheapest form of lumber is used, which is often allowed to remain in the trench, as costing less to leave than to remove it, while in Fig. 26 the timber walls are made of heavy planking so arranged as to form a mold around each section of conduit remaining in place only until the concrete is tamped and set, and then being pulled along to serve for the next succeeding section.

4.—WOOD-PULP DUCTS.

The most recent suggestion for duct material is that embodied in the use of wood pulp or paper in the construction of a tube which forms the desired "hole in the street." From time to time the use of some form of fibre has been presented for the purpose, but it is only recently that an asphalted-paper pipe has been perfected sufficiently to make a commercial article. The Electrolysis Proof Conduit Company is placing before the electrical engineer a tube composed of paper pulp saturated with asphalt, tightly rolled and thoroughly compressed so as to form an exceedingly durable and valuable structure. It is made in lengths of ten feet or more, provided with male and female ends, the joints being completed by dipping each length as it is laid in hot asphalt and driving it home upon the preceding piece. The method of constructing the subway with this form of duct material is exactly the same as that employed for cement-lined pipe. Fig. 27 shows the construction of a 7-duct conduit, built of electrolysis-proof ducts as installed in Salt Lake City, and is so self-explanatory as to need no further comment. It is claimed that this form of duct material possesses the advantages of being indestructible underground, of extreme lightness, and, therefore, cheap and rapid in construction; entirely water-proof and of good insulating properties. It would certainly appear that paper pulp, thoroughly saturated with asphalt, would be practically rot-proof, but as this assertion has not yet received the actual test of time, a final verdict must be reserved until this opinion has received the conclusive test of experience. Of its lightness there can be no question, as the duct material weighs about two pounds per linear foot, and for this reason, freightage, cartage and handling are decidedly easier than is the case with any other forms. As the paper tube is very tough, there is no

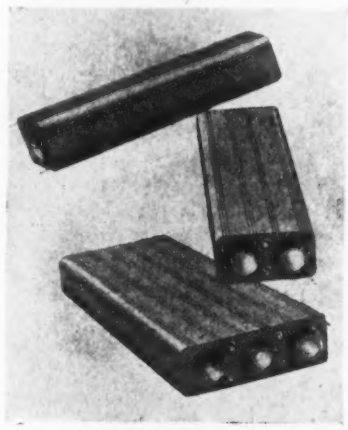


FIG. 22.—ROUND-HOLE MULTIPLE DUCTS.

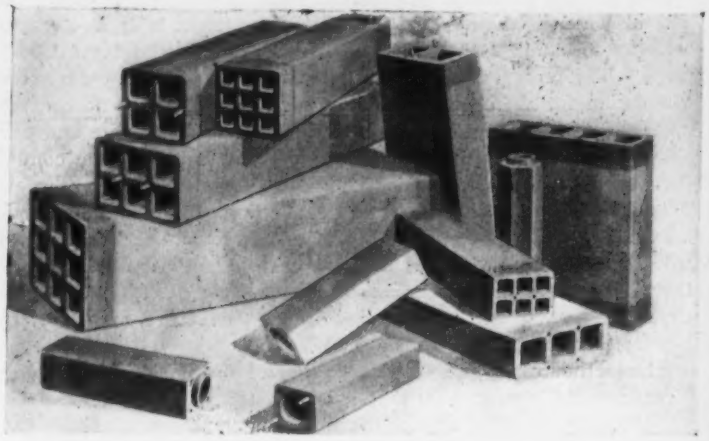


FIG. 23.—SOME MULTIPLE DUCT FORMS.

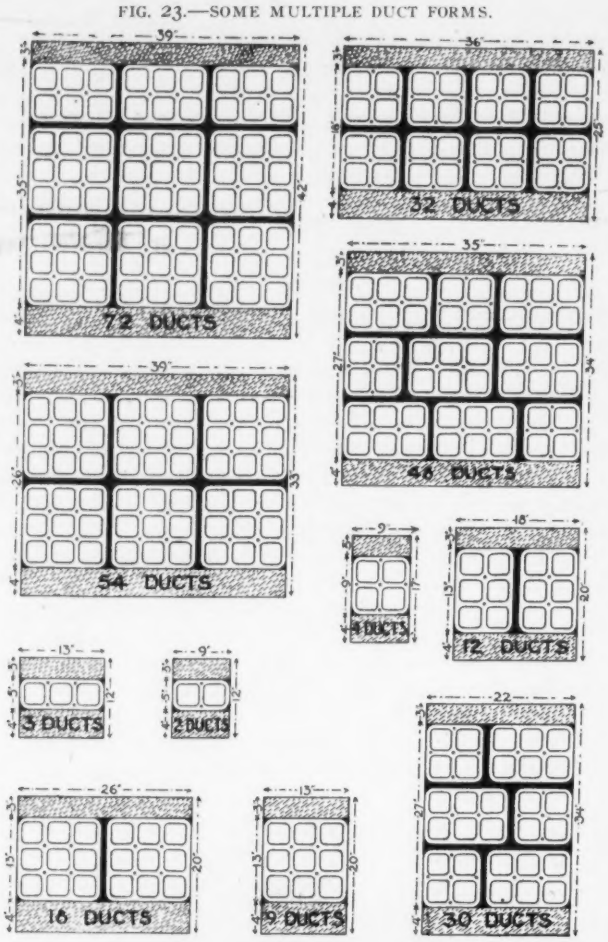


FIG. 24.—GROUPINGS OF MULTIPLE DUCTS.

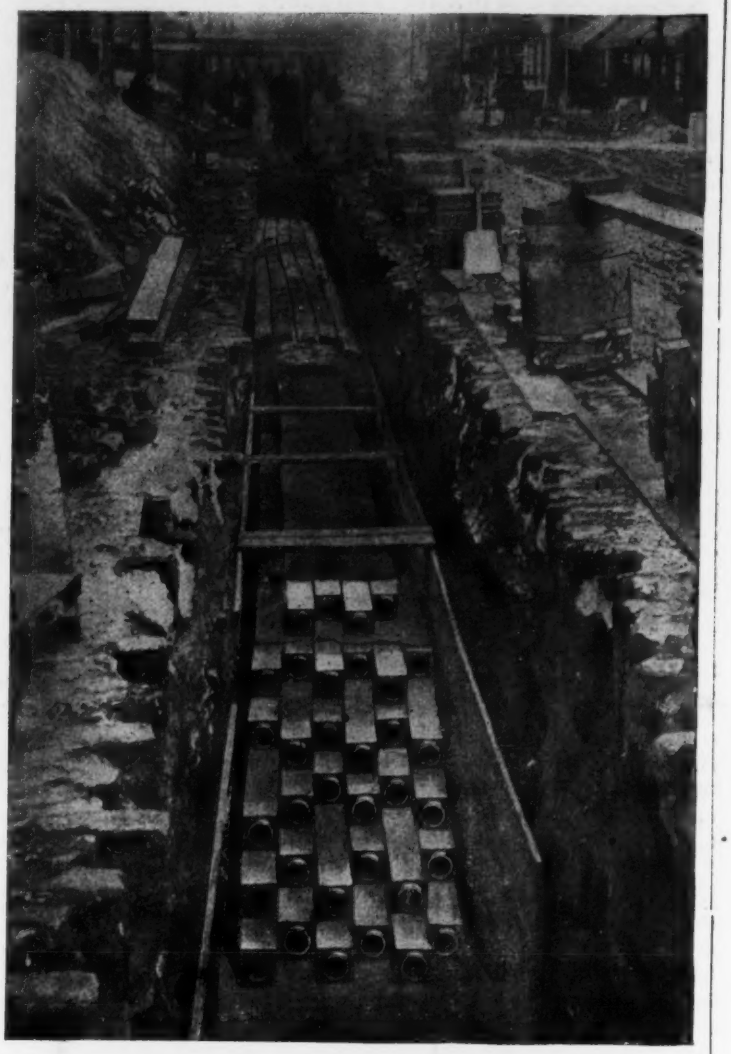


FIG. 25.—SUBWAY OF 34-SINGLE-DUCTS.

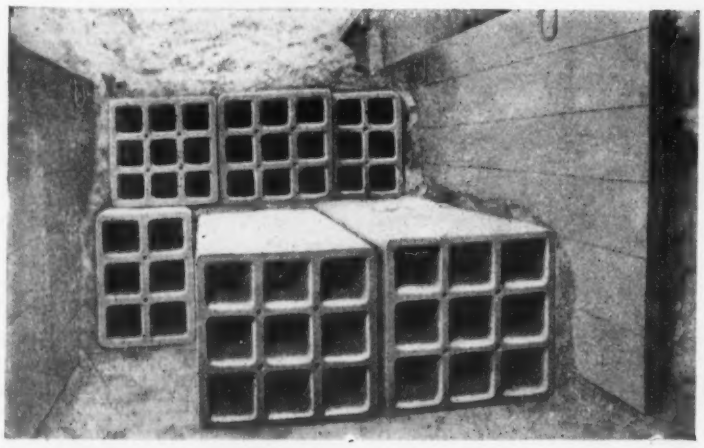


FIG. 26.—MULTIPLE DUCTS.

FIG. 27.—ELECTROLYSIS-PROOF CONDUIT.

FORMS OF TELEPHONE MULTIPLE DUCTS AND METHODS OF INSTALLATION.

reason for breakage—an item of some moment in the vitrified clay forms. Also the paper tube can be readily cut to any desired length with a saw, and the proper socket reamed upon the fresh end with an adequate tool. In all these respects the electrolysis-proof conduit presents distinct advantages. A strong claim for the use of this form is that its high insulating qualities will render the cables immune from parasitic electric currents, and thus, as its name indicates, relieve the telephone engineer from the street railway current bugbear that is supposed to menace cable sheaths. That this duct material has high insulating properties there can be no doubt, as it is abundantly substantiated by the tests which its manufacturers quote, showing that it has successfully withstood 40,000 to 50,000 volts.

It would certainly be highly desirable, if practical, to obtain a conduit which would be a perfect insulator, and so protect the cable from any possible exposure to electrolytic action, but to accomplish this it is not only necessary that the duct should be a perfect insulator, but also that all manholes, distributing boxes, cable terminals and other parts of the subway must have equally high resistances, for if any point fails to protect the system breaks down. Also the entire structure must be absolutely moisture-proof, or otherwise no matter how good an insulator the material, it will sooner or later become coated with a moisture film and its insulating qualities, so far as the cable sheaths are concerned, destroyed. Such an ideal subway has never appeared, and the task of installing one is too herculean to tempt most telephone engineers, so in the absence of moisture-proof manholes and other auxiliaries, the specific resistance of the duct material is a matter of small moment.

Annual Meeting of the New York State Street Railway Association.

The twentieth annual gathering of the New York State Street Railway Association was held on Sept. 8 to Sept. 11, at Caldwell, on Lake George, at the Fort William Hotel. The programme for the meeting itself was carefully arranged, and provision had been made for the discussion of several very important topics. The business sessions began Tuesday morning with a meeting of the executive committee at 9 o'clock, followed an hour later by the formal opening of the convention. Tuesday was given up entirely to the business of the Association and sessions were held during both the morning and afternoon. The annual banquet was held in the evening at the Fort William Henry Hotel. About 200 delegates and guests sat down. Speeches were made by Messrs. Rogers, Colvin, Daly, Powers, O'Connor, Brady, Stedman and Ely. Mr. Colvin acted as toastmaster. Wednesday morning was devoted to the sessions of the Association, and the final business sessions of the Association were held on Wednesday morning. A number of interesting trips and excursions were provided for the ladies and delegates.

President Rogers made, as usual, a valuable and suggestive address, in the course of which he said: It is my belief that in the near future the steam roads will seek ownership or a closer alliance with electric lines which will serve as feeders to them, as is illustrated by the acquisition and extensive construction of roads by the New York, New Haven & Hartford and other steam railways. The advantages of such an alliance to both parties are numerous and cannot help but be a benefit to the public and property. In the recent decision by the Court of Appeals in the suit brought by the Hudson Valley Railway to compel the Boston & Maine Railroad to make a physical connection of their tracks and to interchange freight, the court held that the Legislature of the State has recognized electric railways as a part of the transportation system of the State, and that travelers and shippers of freight are entitled to the benefit of all facilities provided for in the articles of incorporation of transportation companies as well as the duties imposed by the railroad law of the State. The court, after stating that the steam railroads have become great arteries over which the greater part of the commerce of our country is carried, says: "It has not been considered profitable or practicable for steam roads to be constructed to every village, hamlet or productive district in the country. This, however, is being rapidly accomplished by the numerous electric roads that are in process of construction or are contemplated. By their means the farmer and mill owner and the merchandise vender in distant places may be able to reach the steam roads, and through them the great markets of our cities, with their merchandise and products, and in this way one road may become the feeder and distributor for the other."

In development of the same general subject, Mr. Rogers said: The great activity in electric railroad building, which surpasses the most sanguine expectations of a few years ago, is in a large measure accountable for the falling off of the increase of new mileage by the steam railroads of over 50 per cent. between 1890 and 1900, as compared with the interim between 1880 and 1890. When a steam road is requested to give additional train service by the public, the public is often met with the reply, "Another train won't pay." By this policy they do not stimulate travel. The electric road doesn't wait for business, but goes after it, and the result is that when they tap a territory of an existing steam railroad, they increase the rides per capita per annum many fold over what they were with the steam roads. This is largely due to lower fares and more frequent service. The cordial relation existing between the steam railroads and street railways of this State is a matter of favorable comment and congratulation, and make possible a great deal in the way of development and interchange of business from which the general public inherit an untold benefit that would not be available if this friendly relation did not exist.

Mr. C. R. Barnes presented a valuable and timely paper on "Accidents on Electric Railroads," based upon his experience as a member of the New York State Railroad Commission. He gave the following statistics: In the year 1898 there were 1,174.38 miles of electric railroads in this State; 4002 box, 3408 open, 10 mail and 208 freight, express and service cars operated. In that year there were 74 persons killed and 541 injured. In 1899 there were 1,225.16 miles of road; 4743 box, 3681 open, 139 mail and 631 freight, express and service cars operated. There were 126 persons killed and 589 injured. In 1900 there were 1,413.26 miles of road; 5098 box, 3666 open, 22 mail and 666 freight, express and service cars operated. There were 148 persons killed and 650 injured. In 1901 there were 1,548.66 miles of road; 5190 box, 3945 open, 10 mail and 558 freight, express and service cars operated, and 160 persons were killed and 867 injured. The complete reports of mileage and the number of cars operated for the year ended June 30, 1902, have not yet been received in the Railroad Commission office. In this year to June 30 there were 127 people killed and 823 injured. They were all familiar with the serious accidents which have occurred since June 30, one of which resulted in 14 deaths and the injury of 60 persons; another in 4 deaths and 20 or 30 injured; one where three were killed and several injured; two where one was killed and several others where a number were injured. These figures show that the death rate caused by accidents in reference to miles of road operated was .063 in 1898, .102 in 1899, .104 in 1900, and .103 in 1901. As stated above, these figures cannot be given for 1902. But, with the exception of the year 1901, in which year the death rate in proportion to miles of road was less than the year previous, there has been a continuous increase in the death rate as compared to the mileage. This increase between the years 1898 and 1901 was .040, an increase of about 63 per cent. The percentage of passengers injured in reference to miles of road operated in 1898 was .462; in 1899, .480; in 1900, .450, and in 1901, .559. This shows a steady increase in the percentage of passengers injured in reference to mileage of road except in the year 1900, when the percentage was less than in the year previous. There has been an increase between the years 1898 and 1901 of .097, an increase of about 21 per cent.

He stated that the greatest loss of life and the greatest injury to passengers in the last five years had been due to rear end collisions; with head-on collisions next, and, he added: "The statement can safely be made that in a large majority the primary cause of the accident can be traced to inefficient management of the road." He added: The accidents at grade crossings of steam and electric railroads and at grade crossings of electric railroads, are invariably caused by violation of the running rules of the company, for I do not know of a crossing of steam and electric tracks in this State, where there is any considerable volume of traffic on the steam road, but what the company's rules require the electric car to come to a stop and the conductor to go ahead and flag his car over the crossings. But some collisions have been caused by the power giving out while the electric car was going over the steam tracks, or by the trolley leaving the

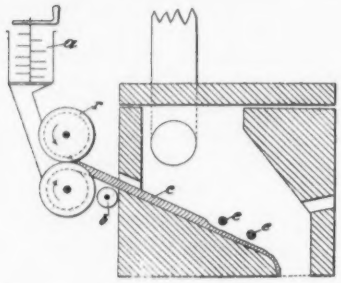
wire while this was being done, in this manner stalling the electric car in front of the steam train or engine. At nearly every crossing of two electric tracks the cars on one of them are required by the rules to come to a full stop before proceeding over the crossing.

Mr. R. E. Danforth presented an interesting paper on "Power House Accounting," in the course of which he said: Power station records are kept for a two-fold purpose—to show the cost of power developed, and to enable the management to locate the uneconomical features of the plant. The accounts should show the amount of power generated or distributed, and the various items, more or less classified, which enter into the cost of such power. It is, for instance, important to know that your firemen generate steam with the proper amount of fuel per horsepower, that the engines and generators convert this steam into electric power, with the least possible loss, and that in each of these operations the machinery is not only being worked to maximum efficiency, but with a minimum cost for repairs. It is further important to be able to determine whether the various units are cut in and out of service at the most economical time, to the end that the proper kilowatt capacity, and no more, is at times being operated.

Some Electric Furnace Methods.

BY CLINTON PAUL TOWNSEND.

In recent issues of this journal, several forms of electric furnace for glass melting have been described, each designed for continuous operation, and each seeking to avoid contamination of the product through direct contact with the heated carbon terminals. In the most recent structure of this type, herewith diagrammatically shown, we find drawn for the first time a distinction between a continuous feed of the raw material, and its continuous passage through the melting zone. In feeding a fusible pulverized charge to the zone of radiation from the arc it is first agglomerated, then melted; and the agglomer-



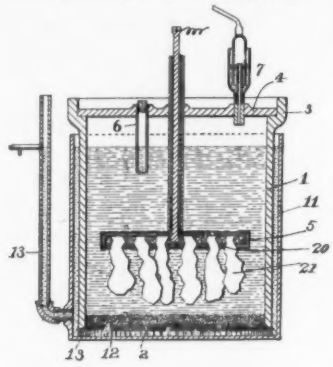


FIG. 1.—BRONN ELECTRIC FURNACE. FIG. 2.—SOMMER ELECTROLYTIC CELL.

ation of the particles into masses interferes with the absolute continuity of their passage beneath or between the arcs, rendering necessary an artificial stoking, and such stoking almost inevitably involves an intermittent contact of the charge with the electrodes. From such contact arise the difficulties of contamination of the melt, of rapid and unequal wear of the carbons, and of a non-homogeneous product.

The solution now offered by Jegor Bronn, of Cologne, Prussia (a brief note of which was made last week), is essentially that heretofore suggested by several workers in the calcium carbide art—to first agglomerate the powdered charge by means of a suitable binding agent, and to feed it in the form of a continuous rod or band into the immediate proximity of the arc. In the carbide methods referred to, the agglutinant has usually been tar, or other hydrocarbon, a carbohydrate, or such compound as will not contaminate the product; so in the present case, the binding agent must be such as will not color or interfere with the transparency of the glass. For this purpose water-glass, hydraulic lime, plaster or even water are suggested. The charge is mixed in the hopper, *a*, formed into bands or rods by rolls, *r*, dried by other heated rolls, *b*, and passed as a continuous body, *c*, over the inclined hearth beneath the arc terminals, *e*; or the rod may be fed downward between lateral arcs to the hearth.

In the manufacture of glass there appears to exist no reason for an intermittent operation; it is quite otherwise, however, with the manufacture of calcium carbide. This carbide, like glass, passes through a partially melted or viscous stage, but, unlike glass, it is not strictly necessary that it should at any time reach a temperature of complete fluidity; and a continuous process which depends for its continuity upon such complete fusion as will permit free tapping, must necessarily consume considerably more electrical energy than an intermittent or continuous method operated at the lower temperature limits.

Dr. Isaiah L. Roberts notes that the carbide ingot resulting from the intermittent method, as commonly practiced, is non-homogenous, but contains near the bottom an excess of lime and near the top an excess of carbon. This would indicate that a stratification of the charge occurs as fusion is reached, the coke, in which form carbon is usually supplied, tending to rise to the upper portion of the molten bath. His solution of the difficulty is to substitute for the coke the specifically heavier anthracite coal. Dr. Roberts claims for this substitution the advantages of a more nearly homogenous ingot, due to the absence of stratification; a more nearly dustless operation, due to the higher specific gravity of the coal; an increased yield, attributable to the combination of substantially the whole of the elements of the charge; and a less porous and, therefore, less hygroscopic product.

PRODUCTION OF CAUSTIC SODA.

An electrolytic cell for the decomposition of brine, the invention of Adolph Sommer, of Cambridge, Mass., interpolates into familiar constructions two or three interesting features. The type is that of Le Sueur—an inverted bell of stoneware, containing the anode and resting upon supports in an iron cathode tank, the mouth of the bell being closed by a diaphragm; in operation brine is introduced within the bell, and the caustic withdrawn from the external tank. As shown in the accompanying figure, the covered bell, 1, 4, rests on a series of spaced insulating blocks, 12, within the cathode tank, 11. The diaphragm, 2, which closes the mouth of the bell, is formed of a sheet of wire cloth, which is electrically unconnected, covered by bed of loose sand. Brine is admitted through a water joint, 7, which serves also for the eduction of chlorin, and the caustic is withdrawn through an adjustable pipe, 13. The anode is of a familiar construction, rough blocks, 21, of retort carbon being secured by casting into a lead base, 5, protected by an insulating sheath, 20. Points of novelty are the unconnected wire gauze diaphragm support, and the tube, 6, the latter serving for the introduction of solid salt which, during operation, rests upon the back of the anode.

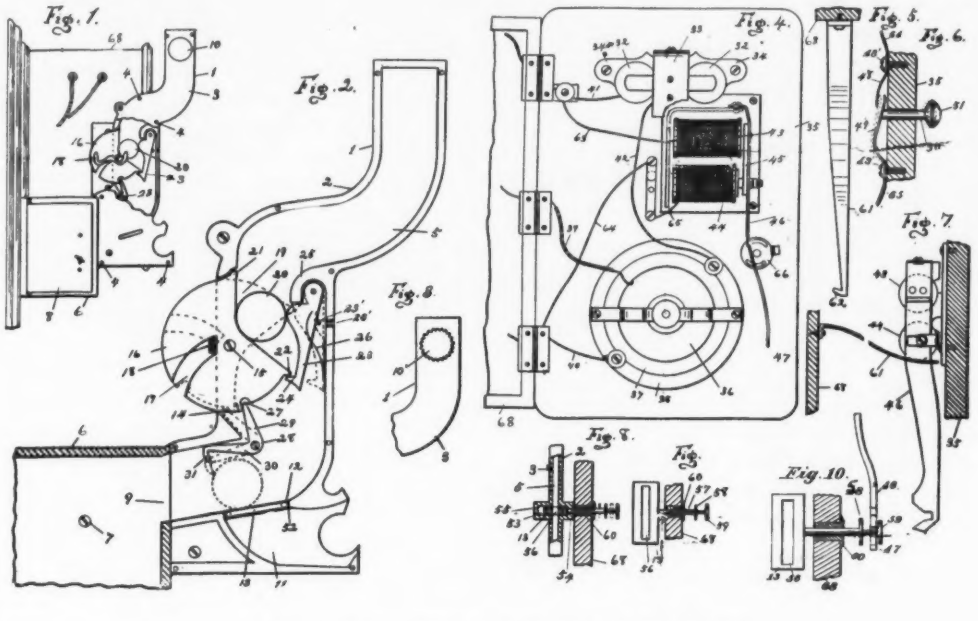
New Telephone Patents.

The issue of the Patent Office for September 2 contributes an addition to the growing collection of nickel-in-the-slot telephones in a coin-controlled telephone, the invention of Mr. Sylvester P. Grey, of Fort Wayne, Indiana. Mr. Grey's device has several ingenious features and to some extent avoids the formidable complication of delicate parts that rob many automatic pay station telephones of practicability. The present invention, however, shares with others the disadvantage of being restricted to nickel service, as it is operated by a coin of predetermined size, and the standard American coin of predetermined size is the nimble nickel.

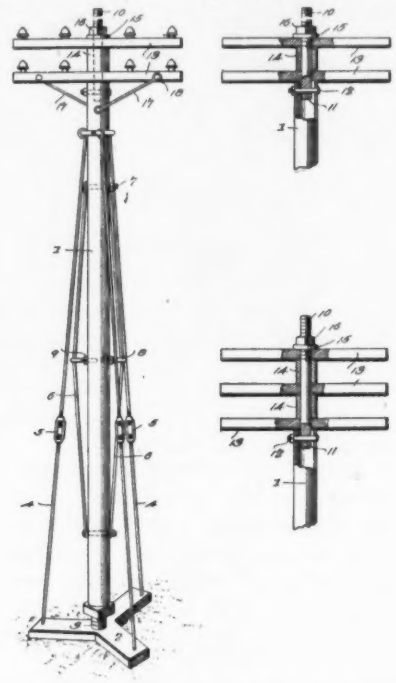
Referring to the drawings, Fig. 1 gives a general view of the coin-mechanism attached to a telephone, part of the case being broken away to show the working parts. Fig. 2 shows the mechanism in detail. Fig. 3 the chute with a special aperture. Fig. 4 a view of the apparatus on the door of the telephone box, the additional parts over the regular telephone instruments being the magnets 43, 45 and lever 46 to operate the coin-releasing device. Fig. 5 shows a hook adapted to engage the lever 46 to prevent the door of the telephone box from being opened by an unauthorized person; Fig. 6 the contacts to close the circuit of magnets 43, 45 when a coin is to be released; Fig. 7 the details of the lever 46 with hooked end 47 adapted to operate the coin releasing slide 13 shown in detail in Figs. 8, 9 and 10. The apparatus puts it within the power of the central operator to return the coin deposited to the caller should the application for a connection be for any reason unsuccessful.

Referring to Figs. 1 and 2 it will be seen that the coin chute, formed of two grooved plates, 2 and 3 clamped together, has a lateral opening, 10, near the top, this side opening being effective

in preventing tampering with the mechanism. As shown in Fig. 3 the aperature may be made with a serrated edge to fit special metal checks to be supplied to subscribers or wholesale customers to use instead of coins. The coin-controlling mechanism consists of the disk 16 having the inclined surface 19, adapted to receive the coin, the lugs 21 and 22, the notch 27 and the slot 17 in which the stem of the switchhook 18 works to revolve the disk. The disk is normally held in position by the cam lever 23 which is pressed forward by a spring, 26, and engages lug 22 by hook 24. When a coin, 20, is deposited it fills up the space between the surface, 19, of the disk and the cam shoulder of 23; the switchhook can then be raised and the disk turned, the pressure of 20 on 23 forcing hook 24 away from lugs 22, and, as the disk comes round, lug 21 bears on the cam of 23, forcing it clear back to the position shown in dotted lines (Fig. 2) and allowing the coin to pass down the chute until it is arrested by the hook, 31, on bell-crank lever 28. It will be seen that the radius of the disk, 16, between the notch 27 and the lug 22 is reduced, so that when the disk is turned in a clockwise direction by the raising of the switchhook the upper end of the holding-pawl, 28, drops back, as shown in the dotted lines and the lower arm drops forward across the chute, placing the hook 31 in a position to retain the coin directly over the slide 13. This slide or valve normally closes the slot 52, by which the coin may be passed into the receptacle 11, whence it may be recovered by the caller in the event of a non-connection.



FIGS. 1 TO 10.—GREY COIN-CONTROLLED TELEPHONE.



FIGS. 1, 2 AND 3.—WARNER POLE.

When the connection goes through all right the slide 13, of course, is not operated, and when the receiver is restored to the switchhook the disk is turned contra-clockwise back to its origianl position, thus raising the hook 31 and allowing the coin to fall into the cash-box 6. The slide or valve, 13, controlling the opening, 52, into the return box is shown in Figs. 8, 9 and 10. The slide works in slots made in the sides of the chute as shown in Fig. 8 and is pulled to and fro by the armature lever, 46, of magnet 43, 44, the lever engaging, by means of hook 47, the pin 57 attached to the slide; the hook 47 works between the two collars, 58, 59, attached to the pin 57. When the desired connection cannot be obtained the caller (so instructed by the operator) presses the button 51 (Fig. 6) which closes the circuit of the magnets 43, 44; the operator then puts current through the magnets and the attraction of the armature causes the slide 13 to be moved to one side, opening the slot 52 and thus giving free passage to the coin into the return box. A neat addition to the device is the screw-threaded lug 23′ on 23 (Fig. 2) by means of which with a special key the hook 23 may be retracted to dislodge any coin, check or slug that may have blocked the instrument.

A correspondent of the ELECTRICAL WORLD AND ENGINEER pointed out the other day that a telephone patent recently reviewed related to a device that was as old as overhead wires themselves. The writer of the letter possibly did not know that which cannot escape the observation of any technical man who looks over the weekly output of the Patent Office—that it is apparently the rule of the Patent Office to grant a patent to any applicant, whether the application covers a real invention, a pure copy, a resurrection of some old device, a reshuffling of parts, or a simple mechanical arrangement that any blacksmith could rig up if it were desirable to do things that way. The only thing the Patent Office seems to stick at is interference, and then it sticks hard. But if an application does not interfere with some other it becomes a patent in due course, however innocent the subject may be of any trace of invention or often of any tangible improvement over existing methods.

A case in point is the patent issued to Mr. Isaac M. Warner, of Union City, Michigan, on a telephone or telegraph pole. The pole is a tubular iron or steel pole screwed into a base 2. As to how the base is secured to its base the specification is silent. At its upper end the pole carries a vertical bolt 10, attached to the pole by the transverse bolt 12, and to this vertical bolt are attached the cross arms, bolted down by the nut and washer 16, 15. If several cross-arms are used, spacing blocks, 14, are inserted between them.

The issue of the Patent Office for September 9 contributes two patents to the art of telephony for such widely diverse inventions as an antiseptic mouthpiece and a vibratory-current relay for use in signaling over composite telegraph and telephone circuits. The inventor of the latter is John M. Fell, of Arlington, N. J., and the patent is assigned to the American Telephone and Telegraph Company. Mr. Fell says that in the operation of systems for the simultaneous transmission of telegraphic and telephonic signals over the same circuit it has been found difficult to provide for the telephonic part of the system suitable appliances for sending and receiving call-signals, which, while efficient in their own functions, do not interfere with the normal operation of and are not themselves subject to interference or disturbance by the normal operation of other parts of the system. It is required in the operation of telephone call-signal apparatus for such a composite system that the electrical currents employed in its operation shall not in any way interfere with or disturb the instruments of the telegraphic part of the system or create inductive disturbance in neighboring telephone circuits. Moreover, such apparatus must not itself be liable to disturbance by electrostatic discharges or induced currents, which, owing to the operation of the telegraphic part of the system may appear in the telephonic circuits.

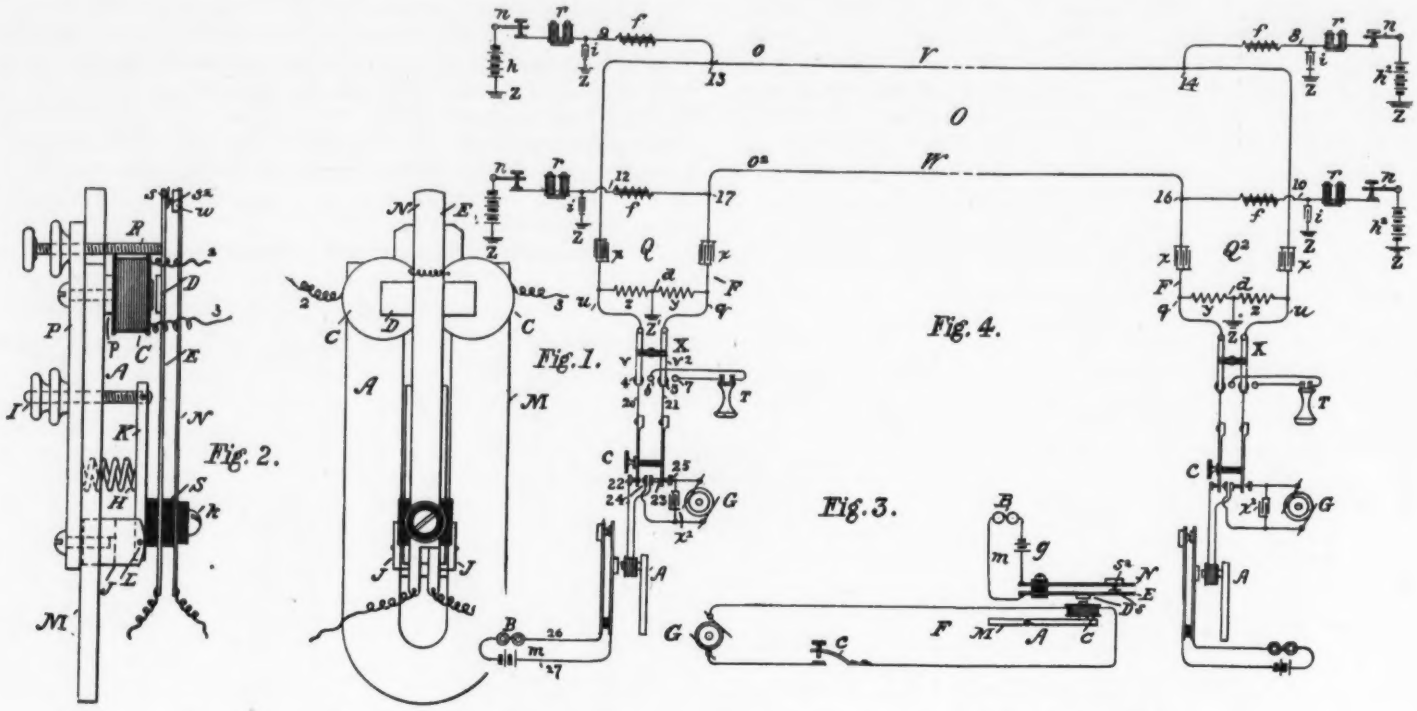
The object of the invention is to provide simple, convenient and effectual means, satisfactorily meeting the requirements for signaling between the stations of the telephonic circuits of such systems, the invention consisting of a call-signal receiving relay which is readily

responsive to alternating currents of electricity, developed by any suitable source, and of such potential and frequency as not to interfere in any way with the telegraphic instruments of the system, or to inductively disturb other telephone circuits. The relay has a permanent magnet, its armature is carried by a spring bar, acting against a stop, which serves to adjust the armature and also to establish a nodal point in the spring bar. A second, but lighter spring bar, of length similar to that of the first, is attached to the same support, and extends parallel to and just above the first. The two springs are insulated from each other at the support, and at the outer ends carry the contact-points of the local circuit controlled by the relay; these points are normally in contact with each other.

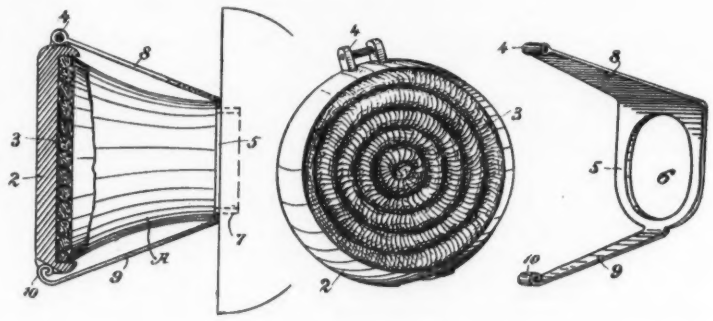
In the drawings, Figs. 1 and 2 show the relay in detail, and Fig. 3 is a diagram of a simple circuit illustrating its use. Fig. 4 illustrates the use of the relay in an improved system of composite telegraphy and telephony. In Figs. 1 and 2, *M* is a U-shaped, permanent magnet, having poles, *p*, fitted with coils *C*. The armature *D* is carried on the spring bar, *E*, which at its outer end carried contact-point *s*, normally in contact with s^2 on bar *N*; the two bars are mounted on the support, *S*, of plates of insulating material, the support being adjustable by means of the link-piece *K*, pivoted at *L* in the post *J*, and governed by the adjusting screw, *I*, against which the compression spring, *H*, presses *K*. By means of *I* the tension of the armature spring, *E*, may be adjusted. The spring *E* beyond the armature bears on a stop, *R*, which prevents the armature from making contact with the magnet poles, and establishes a nodal point in *E*, so that when *E* is vibrated the vibrations of the part beyond *R* are the reverse of those in the part between *R* and S. The spring *N* is lighter than *E* and is weighted at its outer end by *w*, so that the two springs have diverse inertia and different periods of vibration. Therefore, when the armature spring is vibrated by alternating current traversing the magnet, the lighter spring, *N*, does not promptly follow the vibrations of *E*, and the contact between *s* and s^2 is broken or its resistance so raised that the circuit is substantially opened, and the signal operated. The vibration amplitude of *E* is greatest when the current in the relay is of the same frequency as the fundamental periodicity of vibration of the spring. The relay is quite operative when the current frequency is either much below or much above the periodicity of the spring.

In Fig. 3 the relay, as described, is shown joined up in a typical circuit with an alternating generator, and arranged to control a local circuit including a signal. In Fig. 4 is illustrated the application of the relay to a composite telegraph and telephone circuit, in which a metallic telephone circuit, *O*, is employed to furnish two telegraph circuits, *o* and o^2. The circuits are arranged in much the usual manner with impedance coils and condensers, the switches, *X*, controlling the talking circuit of the telephone stations and the keys, *c*, the telephone signaling appliances. Alternating currents of a frequency of approximately 300 periods per second and a potential of 20 volts have been found suitable for the operation of the relay *A*. A condenser, x^2, is bridged across the generator terminals to round off the signaling current, which has no effect on the telegraph instruments, and can be transmitted to considerable distances without serious attenuation.

A good many inventors are troubled by the idea of infection through telephone mouthpieces. The latest thing in antiseptic attachments is due to Messrs. Henry C. Smith and Mark H. Woolsey, who have devised a hinged cap or cover, 2, attached to a bracket, 5, clamped to the transmitter face by the mouthpiece *A*, as clearly shown in the drawings. The cap, 2, is hinged to the upper plate of the bracket at 4, and the lower plate forms a spring fastening at 10 for the bevelled edge of 2. The interior of 2 is charged with suitable absorbent material, 3, saturated with sterilizing or antiseptic substance. The cap is normally closed, bringing the saturated absorbent in contact with the periphery of the mouthpiece, cleaning and sterilizing it, and preventing the ingress of dust. The closed cap also prevents rapid evaporation of the antiseptic, and confines any vapor to the mouthpiece, where, to paraphrase the inventors, it will do the most good.



FIGS. 1 TO 4.—FELL VIBRATORY-CURRENT RELAY FOR COMPOSITE TELEPHONE AND TELEGRAPH CIRCUITS.



FIGS. 1, 2 AND 3.—ANTISEPTIC MOUTHPIECE.

Low Fares.

The Essex Cross Railway Company, which is trying to obtain a franchise through East Orange, N. J., has made a special offer of 2½-cent fares as an inducement to the granting of the privilege.

Electric Railway Systems.

An electric railway system is the subject of a patent, granted on September 9, to T. E. Murray and J. Van Vleck. The system provides an arrangement whereby the controller is operated by means of a solenoid, which is in turn controlled by a centrifugal governor connected with the car axle. As the speed of the car increases, the controlling resistances are cut out by the action of the centrifugal governor, and current is passed through a solenoid, which releases a brake-shoe normally held in contact with the wheel with spring tension. If the car should speed excessively, the centrifugal governor by moving still further will actuate the controller so as to cut in controlling resistance, and if the speed is very high, all of the controlling resistance will be cut in and the brakes applied. The patent also covers details with reference to a sectional-conductor system, which provides a dead section in advance and in the rear of the car, as a protection against collisions.

Another patent was granted to the same well-known engineers, the object of which is well described in the preliminary paragraphs, which are substantially as follows: The general construction and arrangement of the apparatus is such that, first, a car starting from a principal depot or any given station, will automatically proceed to and stop at any other given station; second, prior to reaching the predetermined station said car will automatically close a switch for leading it upon the station siding; third, prior to reaching the predetermined station the strength of the current actuating the car will be automatically reduced; fourth, prior to reaching the predetermined station an electric brake mechanism will be automatically applied to retard the motion of the car; fifth, the line conductors in proximity to the track are disposed in block sections, and by means of suitable automatic mechanism the section next to and immediately succeeding that occupied by the car is rendered dead, so protecting the car from rear collision; sixth, the car mechanism being adjusted for a predetermined speed, any excess speed will result in the automatic operating of mechanism to reduce the speed to normal; seventh, in event of the automatic switch-controlling mechanism not properly setting the switch, the car is automatically brought to a stop before the switch is reached, and cannot proceed until the fault is corrected; eighth, the track is double, and stations are located on loops extending from one track to the other, but in a different plane—that is to say, the loop may preferably rise over the tracks or descend below them—the stations being located on said loops; ninth, in case a car passing from a loop to the main track is in danger of a rear-end collision with a car on the main track, the car first referred to is automatically stopped; tenth, in case a car on the main track is in danger of a rear-end collision with a car coming to the main track from a loop, the first car is automatically stopped.

The patent refers principally to the construction and arrangement of brake mechanism and associated devices. The necessary control of the current on the car and the application of the brakes are effected by means of a centrifugal governor, operating an arm over a series of contacts which make appropriate connections. The necessary changes of switch-setting and energizing or de-energizing of power-rails in the permanent way are accomplished by solenoids connected electrically in the wiring system of the permanent way and mechanically to the devices to be actuated. Mr. Murray is the general manager of the New York Edison Company, and Mr. Van Vleck is now connected with the New York Rapid Transit system.

Water Power Development in Pennsylvania.

At points on the Susquehanna River, in the vicinity of York, Pa., operations on four gigantic electrical power plants are under way. At Conowingo Falls a $4,000,000 company is constructing a 35,000-hp plant to transmit power to Wilmington, Del., and Chester, Pa. B. Harvey Welsh, of Philadelphia, is the hydraulic engineer. A 40,000-hp plant will be located at Peachbottom and McCall's Ferry. The company constructing it is capitalized at $10,000,000, and has for its president David Warfield, of Baltimore. The power will be transmitted to Baltimore and intermediate points. At York Furnace fifteen men, under the direction of H. F. La Bella, engineer for the American Pipe Company, of Philadelphia, are making surveys for a 40,000-hp plant. Major George B. Burbank, of New York City, has been selected as hydraulic engineer for the Susquehanna Power Company.

CURRENT NEWS AND NOTES.

BRITISH PACIFIC CABLE.—The steamship Colonia, from Liverpool, with the Pacific cable on board, has reached Victoria, B. C. After coaling it goes on to Bamfield Creek, on the west coast of Vancouver Island and the terminus of the cable, where it will commence laying the cable.

POULSEN'S TELEGRAPHONE.—According to a Copenhagen dispatch the Danish company which is exploiting Poulsen's telegraphone is considering an offer from America to buy the patents on the invention for $600,000 cash, and one-third of the shares of an international company to be formed.

PRIZES OF BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.—The British I. E. E. has made announcement of the award of the following annual premiums and scholarships for the year 1902: David Hughes Scholarship, £50, to Edward Fisher, of Finsbury Technical College; Sir David Salomons' Scholarship, £50, to Philip A. Laubach, of Finsbury Technical College; Fahie Premium, £10, to Mr. I. G. Brown, for his paper on automatic submarine cable relaying; Institution Premium, £25, to Mr. O. Losche, for his paper on the Zossen railway trials; "Paris Electrical Exhibition" Premium, £10, to Mr. H. W. Clothier, for his paper on high-tension central station switch gears; a premium of £10, to Mr. David Robertson, for his paper on armature winding diagrams. In addition there were awarded one extra premium of £10 and two of £5, and four students' premiums of £10, £5, £5 and £3, respectively, all for papers read before the Institution.

MARCONI'S LATEST ACHIEVEMENT.—The Marconi Wireless Telegraph Company has, according to a special cablegram, issued a statement from its London office stating that it has received "perfect" messages at Poldhu, Cornwall, from Gibraltar continuously during the passage from there to Spezia, Italy. The messages thus passed over France and Spain and over the Alps and across the Mediterranean from the warship assigned to him by the Italian Government. These messages were received on a tape-receiver, the distances of transmission varying between 900 and 1,100 miles. It is further stated that Marconi will at once sail for America on the same warship, the "Carlo Alberto," for the purpose of resuming arrangements for the establishing of a commercial wireless telegraph service across the Atlantic. While on the way over he will be in constant communication with the English station. He will first go to Cape Breton, and afterward to Cape Cod, Mass.

TECHNICAL EDUCATION IN GREAT BRITAIN.—At the recent meeting of the British Association, Professor Dewar painted in gloomy colors the present situation in Great Britain with respect to technical education. He pointed out that it is largely owing to superior technical training that Germany controls the chemical industry, the German output being $250,000,000 annually. It is through an abundance of men of ordinary plodding ability, thoroughly trained and methodically directed, that Germany at present has so commanding an advantage. It is the failure of British schools to turn out, and of British manufacturers to demand men of this kind, which explains a loss of some valuable industries and a precarious hold on others. Let no one, he said, imagine for a moment that this deficiency can be remedied by any amount of that technical training which is now a fashionable nostrum. It is an excellent thing, but it must rest upon a foundation of general training. Mental habits are formed for good or evil long before men go to technical schools. We have to begin at the beginning. The really appalling thing is not that the Germans have seized this or that industry, or even that they may have seized a dozen industries. It is that the German population has reached a point in general training and specialized equipment which will take Great Britain two generations of hard and intelligently directed educational work to attain; it is that Germany possesses a national weapon of precision, which must give her an enormous advantage in every contest depending upon disciplined and methodized intellect. It may be remarked that so far as electrical engineering is concerned, the statements of Professor Dewar will apply in a comparison between Great Britain and the United States.

CROSS-COUNTRY WIRELESS TELEGRAPHY.—A dispatch from Rome, Italy, states that the government is considering the advisability of establishing a wireless telegraph system across the country, and that Signor Marconi will be consulted on the subject.

THE KAISER AGAIN.—At a dinner recently given by the German Emperor, at which were present the American officers in attendance at the war manœuvres, the Kaiser, in referring to the accident to the President at Pittsfield, denounced electric cars as "enemies of humanity."

WIRELESS TELEGRAPH STATION AT CRETE.—The experiment is projected of establishing wireless telegraphy stations in Greece, on the Island of Crete, for the purpose of communicating northward with Italy, and to the south with Egypt, which would enable a great reduction in the telegraph charges between these countries.

A SMALL PLANT'S LONG RUN.—Mr. S. S. Hartzell, of the Hartzell Light and Milling Company, Poplar Bluff, Mo., writes: We shut down our engine and closed our fan season this morning, September 7, after a continuous, uninterrupted run of seven weeks, or 1,176 hours. There was no real necessity for stopping, as engine and dynamo were both in good order. Our main-drive belt during this time traveled 72,486 miles. This run, which shows what can be done 24 hours daily from a small plant, was made with a 16 x 36 heavy duty Hamilton-Corliss engine, and a 90-kw, 60-cycle Warren generator.

GERMAN ARMY MANŒUVRES.—Two novelties at the German army manœuvres just ended were wireless telegraphy and Boer tactics. The result of the wireless experiments seems completely satisfactory, and in the opinion of the military chiefs will enormously affect the transmission of intelligence during battle. A description of the apparatus is not available, because visitors at the manœuvres when they came close to the stations were requested to retire. The exterior of the apparatus is simply a cubical iron box, about three feet each way, mounted on a wagon resembling a gun carriage and drawn by four horses. The messages sent were caught on a wire attached to a small balloon several hundred feet above the carriage. These stations were moved freely about the field, the horses sometimes going at full trot; but they were stopped for telegraphing. The operator used a key producing a shrill, metallic sound audible for a hundred yards. The cavalry corps, in making its evolutions, kept constantly in touch with headquarters through the wireless telegraph, enabling the corps to hasten or retard its movement, throughout the thirty-two miles' ride, as in the judgment of the headquarters staff changes in the situation were required. It will now be possible to deliver co-ordinate attacks by widely separated divisions in a way hitherto impossible.

AN EARLY SECONDARY BATTERY PATENT.—A patent was granted, June 25, 1867, to Dr. Geo. G. Percival, on "Secondary Electric Piles." In the specifications the inventor states, "I am aware of Ritter's charging pile, but he used plates of copper alone. I am also aware of the various polarization plates mentioned by Faraday, Becquerel, De La Rive and others, who used platinum. I am also aware of a secondary electrical pile, where sheet lead is immersed in dilute sulphuric acid. Also of Kirchoff's patent, February 26, 1861, of Leclanche's patent, dated April 23, 1867, and also of Prof. Thompson's English patent; but I am not aware of a secondary electrical pile being formed of lead combined with some other metal, more especially zinc or copper or iron." As described, the battery consists of a glass jar, containing a saturated solution of sulphate of zinc and two elements, one of which is composed of six plates of sheet lead, each 6 inches long and varying from 3½ to 4½ inches wide, the wide plates being in the middle; alternating with these are seven plates of amalgamated sheet zinc of the same size. The plates are held parallel to each other and one-fourth of an inch apart by a separator of hard rubber. The first operation consists in immersing the elements of a cell in a solution of sulphate of mercury, and passing through the same a current from a Bunsen battery; it is stated that in a short time the zincs are beautifully amalgamated, and the lead is prepared to receive a coat of the peroxide. The plates are then put in the regular electrolyte and charged from a Bunsen battery; in a short time the lead plates are covered with a film of peroxide of lead, and metallic zinc is deposited on the zinc plates. "When the battery has been disconnected, very little action takes place in the pile until the circuit is established, when it will for a short time give a current of surprisingly large quantity. If connection be not made for a week there will still be some portions of the charge remaining, provided a powerful charge was given. By pouring off the liquid and keeping the pile dry, it will retain its charge six months or more." The inventor says that when too much battery power is used he thinks there is a tendency to give off free oxygen from the lead plate of the pile rather than to form peroxide of lead; and sometimes, when the pile is allowed to run down completely, scales separate from the lead plate, but these can be easily removed by a stream of water, and the pile recharged. Sheet copper of the same dimensions may be substituted for the zinc plates, and a solution of sulphate copper for the zinc solution, the other parts remaining the same. Plates of iron and a solution of iron may be substituted in the same manner. Solutions of chloride may also be used.

LETTERS TO THE EDITORS.

Electrode Terminology.

To the Editors of Electrical World and Engineer:

Sirs.—In regard to the use of the terms "positive-pole electrode" and "negative-pole electrode" to indicate the peroxide and spongy lead plates, respectively, as set forth in the article, "Electrode Terminology," ELECTRIAL WORLD AND ENGINEER, July 12, 1902, I have found that the use of the terms was suggested in a paper of Fr. Kirstädter, in Dr. Franz Peters' *Centralblatt für Accumulatoren und Elementenkunde*, 1900, p. 379. This publication was not at hand when I wrote the article, or reference would have been made thereto.

WASHINGTON, D. C. ALBERT M. LEWERS.

Safety in Elevators.

To the Editors of Electrical World and Engineer:

Sirs.—There appeared in your paper of August 16 a criticism by Mr. O. F. Shepard of my article of July 12, on "Safety in Elevators." The question whether elevator accidents are numerous or not numerous might perhaps be termed a matter entirely aside from the question. It is most likely that even if the number of accidents were much smaller than at present, there would be some persons still complaining about their frequency.

The fact that the motor of an elevator is compound-wound is, of course, not of itself an element of danger, and any abnormal increase in speed need not occur as long as the machinery is operated as intended by its builder. It is, however, possible in elevator service that the motor may act as generator before the attendant has cut out any of the series winding, and then the speed will greatly increase. A considerable speed increase will occur even if the motor is shunt-wound, and becomes a generator before its starting resistance is cut out, but the said increase will naturally be greater in the case of the compound-wound motor. It may amount to a great deal more than the 25 per cent. computed by Mr. Shepard, but in these days of close regulation of electric machinery even 25 per cent. increase in speed might be considered too great, and had better be prevented.

The arrangement suggested in my article was intended to short-circuit all the resistance in series with the armature, whether the motor is shunt or compound-wound, whenever it is driven as generator, so that the said speed increase will not result if the attendant should fail to cut out said resistance.

Mr. Shepard does not give any good reasons for his statement that the speed governor would seem to be "the only means to prevent a runaway" in case the power supply circuit is opened while the motor is driven as generator. This statement is rather too broad. It is true that the solenoid brake, as ordinarily installed, will not act in such case, but it is not so as a matter of necessity, and the fact is that by the addition of suitable and quite simple apparatus the same solenoid brake will be applied also on this occasion. Since patents are pending on such apparatus, it is, however, not proper to discuss it in detail at present.

NEW YORK. GUSTAVE RENNERFELT.

The Highest Lighting Plant.

To the Editors of Electrical World and Engineer:

Sirs.—Referring to the article under "Current New and Notes," of your last issue, entitled "The Highest Lighting Plant," I beg to state that I have put in operation a lighting plant in South America, within three miles of Casapalea, Peru, "Mina Americana," the latter being at an elevation of more than 16,000 feet above sea level, about 2,000 feet higher than Casapalea. The mine is the property of Señor Alejandro Garland, of Lima, Peru, and is situated at the peak of the water-shed of the Andes Mountains, which at this point are very high. The dynamo is a 5-hp General Electric, direct-current, belted to a Pelton water-wheel, which is supplied with water from a lake some 200 meters distant, the waters of which divide between the Atlantic and the Pacific sides. There are here lighted the factory, in which the ore is crushed and separated, and the miners' dwellings. The place is covered with snow the year around, and many deaths have resulted from the mountain disease, "surroche"—bleeding of nose and general hemorrhages.

Casapalea is about 100 miles from the coast, on the line of the Ferrocarril Central del Peru, between Callao and Oroya, which is the route to the famous Cerro de Paseo region, now being exploited by a North American company, capitalized at $10,000,000. The Backus & Johnston Smelting Company's plant at Casapalea, elevation over 14,000 feet, is also lighted by electricity.

BROOKLYN, N. Y. C. A. NEWBAKER.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Aging of Transformer Iron.—NIETHAMMER, DETTMAR, ROSENBERG.—Several communications on this subject. Niethammer suggests limiting the iron temperature of transformers to 70° or 85° C. as a maximum, as transformers when operated at higher temperature for several weeks show an increase of loss. Dettmar speaks against the proposition of Niethammer, as he thinks that at the temperature usually existing in commercial transformers, there is no appreciable change of the losses due to aging of the iron. He describes some tests which showed that different sorts of iron behave quite differently. Several samples of iron were heated to 130° C. and continually tested; in one case the losses increased by 28 per cent.; in five other samples by 11 to 17 per cent. He is now investigating the question to which degree the aging is due to high temperatures, and to which degree it is due to the reversals of magnetism; he tests simultaneously two exactly equal samples, one being kept at 130° C. without reversals of magnetism, the other being kept at the same temperature, and subjected at the same time to reversals of magnetism. Rosenberg also speaks against Niethammer's proposition, as rules on the temperature should not be based on the properties of "sick" iron, which should never be used for transformers. He refers to some tests of Mauermann, which showed that some sorts of iron after having been kept at a temperature of 77° C. for two weeks had not changed their magnetic qualities, while other samples which had been annealed at too high a temperature showed considerable deterioration of the coefficient of hysteresis, after having been kept for one week at a temperature of 56° C. A comparison of result obtained by Heyn and Mauermann shows that the use of the same excessive temperature produces "sickness" of the iron in mechanical as well as in magnetic respect. Heyn found that overheated, brittle iron can be improved in mechanical respect by again annealing it for a short time at a temperature above 900 degrees, or by annealing it at 700 degrees for a longer time. It is not impossible that iron which is magnetically sick would also be improved in such a way. He refers to a case in which he observed an aging of copper; the copper of a direct-current armature which had been used for several years showed an electric conductivity of about 30, while its original conductivity had been 50.—*Elek. Zeit.*, August 7, 21.

Transformer Hazard.—Low.—An abstract of a paper on "The Station Transformer Hazard," read before the Fire Underwriters' Association of the Pacific. He discusses the use of oil in transformers. He thinks there is only one weakness which he would eliminate in order to reduce the transformer fire hazard, and that is the use of sheet-iron casings, which, in the event of fire or particular station trouble, are easily broken or torn or punctured so as to release the oil and allow it to run out. Transformer casings should be of the most substantial and durable kind. They should, in the larger units, be erected on substantial foundations of concrete or other material of similar durability, and their oil-cooling connections should be so installed as to be free from liability to breakage or interruption, even under such severe conditions as are imposed by fire. In some cases the confinement of transformers in separate fire-proof buildings is to be recommended, but whether it is always necessary to resort to this final expedient is a matter of grave doubt.—*Jour. of Elec.*, August.

REFERENCE.

Closed Slots.—MOLLIER.—An article, illustrated by diagrams on the influence of closed slots in the primary of an induction motor. He gives the characteristic curves of a motor, in which the slots of the primary were first closed and were then cut open; the advantages of open slots are evident therefrom.—*Elek. Zeit.*, July 31.

LIGHTS AND LIGHTING.

Arc Lamps with Impregnated Carbons.—WEDDING.—A paper, read at the Berlin Electrical Society, on a long series of tests of arc lamps with impregnated carbons (Bremer arc lamp, "Flammenbogenlicht"). He first experimented with two carbons placed side by side in a nearly vertical direction, so that they form together an acute angle (as in the Bremer lamp), the voltage and current being kept constant; and the arc being acted upon by a magnetic field. The positive carbon was impregnated and had a diameter of 8mm., the negative was not impregnated and had a diameter of 7 mm.; a reflector was placed above the carbons. He first investigated the influence of varying quantities of fluor-spar, with which the positive carbon was impregnated. For an addition of 0, 8, 15, 20, 40 per cent. of fluor-spar the mean hemispherical candle-power is 1,173, 1,728, 2,505, 2,808, 3,574, respectively, and the watts consumed per candle 0.458, 0.232, 0.162, 0.144, 0.113. The best percentage to be added is 15 per cent., as larger additions have certain disadvantages. The influence of these impregnations is clearly shown in the adjoining diagram, Fig. 1, which gives the candle-power in different

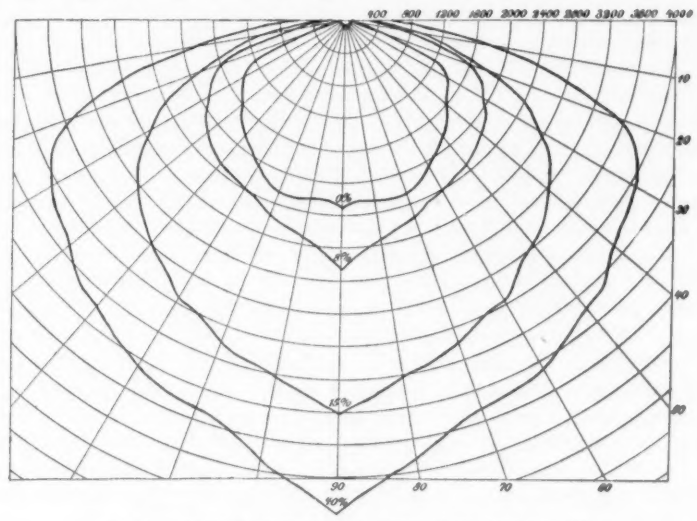


FIG. I.—CANDLE POWERS IN DIFFERENT DIRECTIONS.

directions for varying percentages of impregnation. It is evident how the illumination increases with increasing impregnations, especially up to 15 per cent., and how gradually a sharp maximum, perpendicularly below the lamp is developed. The next object of his investigation was to study the influence of equal additions of differ-

ent materials; calcium gives yellow light, strontium red, and barium white; these experiments were made with alternating current, the current being 9 amperes, and the voltage 47.5; the yellow calcium light gave a mean hemisphere candle-power of 18,818 c., and measured 0.235 watt per c.; the red (strontium) light 1,430 c., and 0.299 watt per c.; the white (barium) light 1,768 c. and 0.242 watt per c.; the calcium impregnation, therefore, gives the best results. Another important result is that when the carbons are arranged, as described, side by side in a nearly vertical position, alternating current does not require a greater consumption of watt per candle than direct current. Nevertheless, he doubts whether the side by side arrangement of the carbons will in practice replace the old arrangement of one above the other. The latter arrangement has, therefore, also been tried with impregnated carbons. The economy is not so good as with the side by side carbon arrangement, but it has other advantages. He compares the distribution of illumination in the plane below an arc

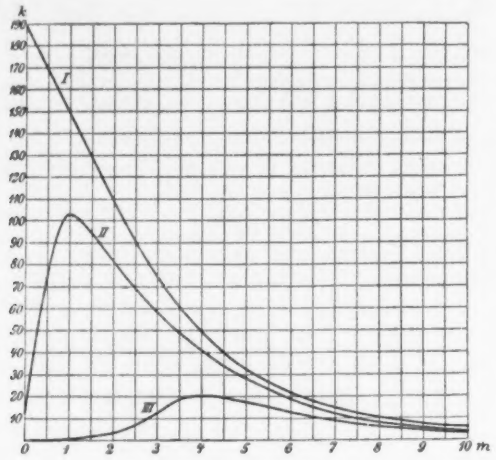


FIG. 2.—CURVES.

lamp, the result being given in the adjoining diagram, Fig. 2. Curve 1 refers to a lamp with impregnated carbons, placed side by side; curve 2 to a lamp with impregnated carbons, placed one above the other; curve 3 to an ordinary lamp with unimpregnated carbons. The current in all three cases is 9 amperes; the voltage for curve 1 was 45, for curve 2 it was 42.6, that for curve 3 is not given (but from a reference to a former paper it appears that this third lamp was an ordinary arc lamp, as they are used, two in series, with a resistance on 110-volt mains, the voltage at the terminals of each lamp being about 40). The ordinates of the diagram represent candles, and the abscissas the distance in meters from the point perpendicularly below the lamp, so that the curves show the variation of the illumination on a plane below the lamp. The superiority of the impregnated carbons is evident. The curves also show the slight superiority in economy of the side by side arrangement over the one above the other arrangement; the maximum of illumination is directly under the lamp in the side by side arrangement, at a distance of 1 meter in the one above the other arrangement with impregnated carbons, and at a distance of 4 meters for ordinary carbons. But these curves refer to arcs without a globe; in practice a globe is used and the conditions change considerably. While there is a slightly less watt consumption for the same candles when the impregnated carbons are arranged side by side than when arranged one above the other, the latter arrangement has the advantage of giving a more uniform illumination throughout a room. The influence of varying voltage at constant current appears from the following figures: The current was 9 amperes, the voltage 37.2, 40.7, 42.8, 47.3; the mean hemisphere candle-power 1,055, 1,153, 1,300, 1,561, respectively; the consumption of watts per candle 0.318, 0.318, 0.296, 0.273; this shows that it is only at high voltages that the economy improves. The voltage cannot be raised beyond certain limits, because otherwise the light is not quiet. He then describes some experiments with the arc itself. He refers to a chemical investigation of Arndt, who found that no dangerous gases are developed during the burning of the lamp with impregnated carbons. He thinks that the new lamps are most suitable for out-door lighting, for large places and long and broad streets.—*Elek. Zeit.*, August 7.

POWER.

Steam-Engine Economy.—WEIGHTON.—An illustrated paper, read before the Brit. Inst. Mech. Eng., on some experiments on steam-engine economy; also some editorial comments on it. Experiments lead him to believe that the economies effected by reheating the steam after it leaves the high-pressure cylinder of a compound engine, and by the use of high vacua with engines running condensing, are both illusory. In the discussion which followed the paper, the opinion generally expressed—especially with regard to the question of vacuum—was that the nature of Weighton's results was due to the design of the particular engine used for the test, and that with an engine properly designed to work condensing, and with a high vacuum, the greater the vacuum the greater will be the economy.—Lond. *Elec.*, August 29.

REFERENCE.

Electricity in a Paper Mill.—An illustrated description of the electric installation in a British paper mill, which was formerly operated by a large number of engines scattered throughout the departments, and in which electricity was introduced a year ago. There are installed 20 motors of, together, 990 hp. The principal advantages of electric power are the greater facilities for regulation of speed and manipulation of the paper in its different stages, but there is also a saving in coal, which is estimated to pay off the first costs in about five years.—Lond. *Elec. Times*, August 14.

Ten Thousand-Volts, Three-Phase Locomotive.—REICHEL.—A well illustrated article on a locomotive for high-speed railways, built by Siemens & Halske. He starts with some remarks on the well-known Zossen high-speed, three-phase railway experiments. While the electric installation for this proved to be entirely satisfactory, the rails were not. It appeared, therefore, important to diminish the wear and tear on the track, and for this purpose it was decided to try the use of an electric locomotive, operated directly on 10,000 volts, so that no stop-down transformers have to be carried on the train, and the weight of the locomotive is considerably decreased. The locomotive has four axles and two geared motors. The primary winding is placed on the stator, and to obtain a large cooling surface, rather deep slots were chosen. The rotor has a radius of 34 cm., and is 30 cm. broad. The stator has 72 open slots and 67 wires per slot, star connection being used. The rotor winding is placed in 90 half-closed slots, and consists of single copper bars, four bars in each slot. The accessories are, with the exception of the rheostats, of the same design as used on the high-speed experimental motor cars. Starting and speed regulation is accomplished, as usual, by inserting resistance in the secondary circuit, the rheostat having 24 stops. The rheostat consists of kruppin wire spirals, connected in parallel. The locomotive has been tested at a voltage of 6,000 to 11,000. The highest speed obtained was 63 miles, as had been the intention. If for high-speed railroads it is intended to use a speed of 96 miles, at a frequency of 35 and a pressure of 8,000 volts, a car equipped with those motors, together with a trailer of 42 tons weight, including passengers, can carry 100 passengers, and there are 1,200 kgr. total weight per passenger. He says that the corresponding figures for steam traction would be 1,800 kgr., so that there is an advantage in favor of electric traction.—*Elek. Zeit.*, August 7.

REFERENCE.

Suburban Railroad.—A long and well-illustrated description of the Aurora, Elgin & Chicago Railway, which operates, electrically, nearly 100 miles of its own track near Chicago, and has connections with several other suburban electric railways. Three-phase currents are used for transmission from the power house to six substations containing synchronous converters and transformers.—*St. R'y. Rev.*, August 20.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Three-Wire Systems.—MORGAN.—An article on distribution with insulated neutral. There should be no fuses anywhere on the neutral conductor; in the outers, however, fuses are a necessity. He suggests placing fuses between each feeder and the distributors connected to it, but not on the feeder itself. A switch on each outer on the station board will in practice be found sufficient protection for large feeders, as the current is always under observation. If it is decided to fuse the feeders, the fuses should be designed to melt at not less than 2,000 amperes per square inch. Wherever the section of a distributor undergoes alteration, a fuse should be inserted, and it would be quite possible to standardize a network with three sizes of distributors, involving, therefore, only three sizes of fuses. He would fuse distributors for about 1,500 amperes per square inch, arranging the fuses in accordance with the section of main, and not

according to the connected load on the section. Finally, he recommends the following system of distribution for three-phase currents: Three-core cables, lead covered, the lead being used as earthed neutral, the lead being wiped on to all boxes, and the services taken off by lead-wiped joints. He would also consider the possibility of dispensing with the neutral conductor, and connecting one wire to the existing water or gas pipes in the consumer's house, but this raises a legal question.—Lond. *Elec. Rev.* August 29.

Middle Wire in Three-Wire Systems.—HOOGWINKEL.—An article in which he advocates the use of an uninsulated middle wire in a three-wire system. While this is not allowed in England, it is in universal use in continental Europe. In England, for the neutral conductor a cross-section is chosen, equal to about 50 per cent. of the outers, while in continental Europe a section of about 25 per cent. is the rule. He speaks in favor of the continental use, and remarks that an uninsulated middle wire is more reliable, as faults in the outers will not remain unlocated or unrepaired. He recommends connecting the middle wire and the armor of the outer cable at intervals of about 50 yards by means of copper section wires. There should be no fuses on the middle wire, neither at the station nor in houses, and the uninsulated middle wire must not enter the network boxes, but should be simply connected up by copper links.—Lond. *Elec. Rev.*, August 29.

REFERENCE.

Chicago.—BLANCK.—A long and well-illustrated article on the system of the Chicago Edison Company.—*Elek. Zeit.*, July 31, August 7.

WIRES, WIRING AND CONDUITS.

Calculation of a Transmission Line.—HUTTON AND CROWELL.—A paper read before the Pacific Coast Transmission Association. The authors remark that since the discovery of great oil fields, the use of fuel oil has begun to compete seriously with electric power in the West. They consider the design of a 50,000-hp, 80,000-volt, 200-mile transmission line. The rule of Scott is mentioned, which recommends using a pressure in thousands of volts, equal to one-third of the number of miles of the transmission line. They assume a somewhat higher voltage, to make allowance for th higher cost of latticed steel poles, which are suggested for use instead of wooden poles. Aluminum is assumed for the tran mission wire, and four cases are analytically treated: First, two three-wire, three-phase circuits, operated at 60 cycles per second; second, two three-wire, three-phase circuits, operated at 30 cycles per second; third, four three-wire, three-phase circuits, operated at 60 cycles; and, fourth, four three-wire, three-phase circuits, operated at 30 cycles. The last system is the most suitable. For a plant of this size, where the bulk of its capacity would be used for driving motors, a frequency of 30 cycles, or even less, should be adopted, using motor-generator sets when lighting is required, thereby getting a much better voltage regulation for lighting than is shown in the average transmission plant of to-day.—*Jour. of Elec.*, July.

Insulation of Electric-Supply Cables.—CHARPENTIER.—A paper in which he points out that the high-insulation resistance usually required of cable makers is not in itself of much value; even if the resistance were reduced to one-thousandth of its usual value, the loss of energy by leakage would be negligible. These high insulations are demanded merely as a guarantee of the quality of the cable, but they should not enter into the specification of a cable, for an insulation of equal durability and equal strength against rupture might have far less resistance and be equally serviceable in practice. The insulation of a cable should satisfy the three conditions of a definite maximum leakage, strength against rupture, and durability. As a measure of the resistance should be taken, that observed when the current has become practically constant, not that after one minute's electrification. The ratio of these two resistances varies largely in different sizes of cables, and for continuous currents the former alone has any practical value. The strength against rupture bears very little relation to the insulation resistance. It depends really on the uniformity of the materials used and the care exercised in manufacture, for over a small surface the thickness of insulation for a given strength is often only about one-tenth that required in a long cable. It is not advisable to test the whole cable, as is usually done, at a pressure double the working pressure, as such a test may permanently injure the insulation. The better test is to measure the pressure of rupture over a length of the cable and allow a factor of safety of 4 to 5. He suggests that cables should be cheapened by substituting, for the armoring, lead sheathing, and for a dielectric of high insulation resistance, a thick layer of moderately insulating material, sufficiently strong to withstand handling and laying, which could be applied to the bare copper as the cable was laid.—*Soc. Int. Elec. Bull.*, March; abstracted in *Science Abstracts.*

Capacity of a Cable.—SCHWEITZER.—An account of a test of a Felten and Guillaume cable 185 meters in length, having an external diameter of 47 mm., a core diameter of 5.7 mm., and an exterior conductor of internal and external diameters 15.3 mm. and 17.2 mm., respectively. It was provided with two lead mantles and two iron bandages. The total volume of the polarized dielectric was 29,290 cc. He endeavored to find a change in the dielectric constant of the insulating medium on varying the e. m. f. The capacity was determined by discharging the cable through a ballistic galvanometer; the charging potentials successively used were 10,100 and 1,000 volts, respectively. In such a case the charge was completed in 25 seconds at the most; the discharge was completed in 10 seconds. Taking these times into account, 34 different charging potentials, varying from 0.77 to 1,840 volts, were applied, under conditions which kept the temperature of the cable constant. The capacity was found to be 0.03715 microfarad, and the dielectric constant 3.569. The extreme values of the dielectric constant were 3.583 and 3.554. The variations were within the errors of observation. It appears, therefore, that within the potentials mentioned, the capacity of the cable shows no alteration.—*Mett. Phys. Zuerich*, No. 2, 1902; abstracted in Lond. *Elec.*, August 22.

Stranded Cables.—HOLITSCHER.—An article in which he defines the "coefficient of the utilization of the space" in a stranded cable as the ratio of the effective copper cross-section to the total available cross-section. This coefficient should he high. He suggests demanding that it should be between the limits of 70 and 75 per cent., but never below 70 per cent. By mathematical calculations and with the aid of diagrams he endeavors to show that this would be a fair and practical requirement.—*Elek. Zeit.*, July 31.

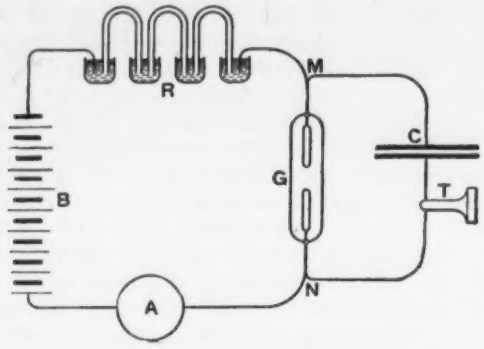
ELECTRO-PHYSICS AND MAGNETISM.

Electrostatic Law.—BARNETT.—A note "on the Cavendish experiment and the law of inverse square in electrostatics." He does not want to cast any aspersions upon the law of inverse square or upon the Cavendish experiment itself, but he claims that a serious fallacy is involved in attempting to investigates the law of force in electrostatics by any such experiment. He points out the importance of inserting the permittivity, or dielectric constant, in the expression for the law of force, the force for given charges being inversely proportional to the permittivity, whatever the law of its variation with the distance. When the medium filling up the whole field is not electrically homogeneous and isotropic, the fact cannot be expressed by a simple law.—*Phys. Rev.*, September.

Application of Lagrange's Equations of Motion to Electric Currents.—DAY.—A paper describing an experiment which is analogous to one made by Maxwell. The latter investigated whether or not any part of the kinetic energy of an electric current could be expressed by a term depending on the product of an ordinary velocity and an electric current. The velocity he considered was a velocity of the wires carrying the current in the direction of its length, and Lagrange's equations of motion show that if the term referred to exists, whenever a current is started or stopped in a wire, there would be an impulse acting on the wire in this direction. Maxwell could not discover any evidence of such an effect. The present author has made an experiment for a similar purpose, but in his experiment the mechanical co-ordinate considered is one whose velocity means a rotation of the wire around its axis, the corresponding impulse when the current is suddenly started or stopped being an impulsion torque, if the term in question exists. But no evidence of the existence of such an effect was discovered.—*Phys. Rev.*, September.

Singing Vacuum Tubes.—RIGHI.—An account of experiments, in which he obtains clear musical notes by means of the apparatus shown in the adjoining diagram, where *B* is a battery of accumulators, *A* a galvanometer, *C* a condenser, *G* a vacuum tube, *R* a copper sulphate resistance, and *T* a telephone. The pitch of the note heard in the telephone increases on increasing the number of cells in the battery, or on diminishing the resistance, the capacity, the pressure in the tube, or the distance between its electrodes. By suitably varying these elements, it is possible to pass through the whole range of musical notes, from the lower to the higher limit of audibility, and beyond. The notes are not due to an alternating current, as in the singing arc, but to a varying period of retardation of discharge in one

direction. The introduction of a considerable inductance makes the phenomenon much more complicated, and approaches the conditions of Duddell's singing arc. As a general rule, an increase of inductance lowers the pitch of the note, but in an irregular manner. At



SINGING VACUUM TUBES.

certain points there is a sudden transition. Thus the gradual introduction of an iron core gives rise to an abrupt succession of notes, sometimes marked by a tremolo at the point of transition.—*Nuovo Cimento*, July; abstracted in Lond. *Elec.*, August 29.

Electrothermal Effect in Tourmaline.—STRAUBEL.—A paper in which he described some experiments made to detect an effect predicted by Lord Kelvin from thermodynamical consideration; if a pyro-electric crystal be brought into an electric field so that the lines of force run from the analogous to the antilogous pole, it will be heated; if the orientation of the crystal in the field is reversed, a cooling will take place. He experimented with a Brazilian tourmaline, and, although his experiments were only qualitative, the results agree with the theory.—*Phil. Mag.*, August.

REFERENCES.

Faraday's Theory.—TROTTER.—The first parts of a long, popular article on "the old and the new electrical theory." He makes some introductory remarks on science, hypothesis and theory, on concepts and precepts, and then goes over to Faraday's ideas of the lines of force. The term current is unfortunate, as it carries with it the suggestion that there is something which flows. But it will probably be impossible to get rid of this term.—Lond. *Elec. Rev.*, August 8, 15.

Röntgen Tube.—HENNE.—An illustrated description of the Gundlach-Dessauer X-ray tube.—*Elek. Zeit.*, July 31.

ELECTRO-CHEMISTRY AND BATTERIES.

Copper Refining.—PHILIP.—Continuations of his long article on the financial basis and design of electrolytic metal refineries, the first part of which was recently abstracted in the Digest. He gives formulas for the costs of various constituents of the plant. In a special case the price of the refined copper may be $375 per ton, the price of anode copper $350 per ton, the output of refined copper 1,000 tons per year, the current density 10 amperes per square foot at anodes, the price of copper sulphate crystals $125 per ton, the thickness of the anode plates 1 inch, and 250 amperes per square inch allowed in the copper current conductors; then his formulas give the total capital invested as $56,125. He then discusses the various items of the annual cost of refining. He then points out the great influence which the current density has upon the capital and annual outlay per ton of copper refined per year; there is, in fact, some particular current density which will yield the most satisfactory financial results, and this particular one varies with the price of coal, the cost of melting down each ton of refined copper into ingots, the rate of wages paid, the rate of interest paid upon the capital invested; and, lastly, but most important, upon the difference in price at the works between the price paid for anode copper and the price obtainable for the refined copper, together with the value of the silver and gold separated from it, if this value goes to the refiner. The current density at the anode used in different plants varies between 1 and 15 amperes per square foot; he is strongly of the opinion that it cannot pay to use a greater current density than 16 amperes per square foot at the outside. He uses his formulas for calculating the different items of the capital investment and the annual charges, to show how all these items vary where the current density is varied between 5 and 20 amperes per square foot. From the results obtained, it appears that the percentage profit on the capital invested, under the particular conditions stated, will be greater when the current density at the anode is somewhere about 15 amperes per square foot.—Lond. *Elec.*, August 15, 22.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Mil-Ammeter and Galvanometer.—SCHAEFER.—The first part of a long article on the capabilities of the mil-ammeter and the galvanometer, in general testing and in submarine cable testing. After some general remarks on cable testing, he points out how certain formulas of formidable appearance are reduced to very simple ones with the assistance of the mil-ammeter which lends itself admirably to a more simple and practical mathematical solution of numerous problems. He then discusses in detail the adaptability of the mil-ammeter to the following problems: To find the internal resistance of a battery, the e. m. f. being known and assumed constant; to find the resistance of a cell or battery and also its effective e. m. f.; to measure a simple resistance; to measure the resistance of earths; to find the resistance of a galvanometer; to find the constant of a galvanometer by the mil-ammeter; to find the e. m. f. of a polarizable battery; to determine the resistance of leakage in a battery and its resultant position; to use an ordinary proportional deflection galvanometer as a mil-ammeter; to find the internal resistance of standard cells. The methods are illustrated by numerical examples.—Lond. *Elec.*, August 15, 22, 29.

REFERENCE.

Hysteresis Tester.—EWING.—A brief communication on his hysteresis tester, by which the hysteresis of a sample is found by comparison with two or more standards whose hysteresis is known. He points out that these standards ought to be checked from time to time.—Lond. *Elec.*, August 15.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wave Tranmission Over Sea and Earth.—JACKSON.—An illustrated Royal Society paper on some phenomena affecting the transmission of electric waves over the surface of the sea and earth. He reaches the following conclusions. Intervening land of any kind reduces the practical signaling distance between two ships or stations, compared with the distance obtainable in the open sea, and this loss in distance varies with the height, thickness, contour and nature of the land; on the basis of the results of these observations, it may be concluded that some of the waves of electric induction, transmitted by wireless telegraphy, may pass through, over, and possibly round the land, and are comparable to the passage of ocean waves through or over a reef, or round high land, which waves proceed along their course with diminished energy, after passing such obstructions. Material particles, such as dust and salt held in suspension in a moist atmosphere, also reduce the signaling distance, probably dissipating and aborbing the waves. Electrical disturbance in the atmosphere also acts most adversely to the regular transmission of these waves, in addition to affecting the receiving instruments by lightning discharges. A system of transmission in which the oscillations are rapidly damped, is irregular in its action on distant receivers, owing to the irregularity of the trains of waves giving rise to different types of disturbance at different parts of their path, which may not have at certain points the necessary cumulative effect on the receiving circuit. The earth's function in the transmission of waves is most important, but its importance is secondary to that of the aerial wire or capacity insulated in the air above the surface of the surrounding sea or earth.—Lond. *Elec. Rev.*, August 22, 29.

Vibrating Cable Relay.—GULSTAD.—The conclusion of his paper, the first part of which was recently abstracted in the Digest. It is said that wherever the vibrating relay has been applied, an immediate and very considerable increase in the maximum speed otherwise attainable, has been the result, although this increase does not appear to be in proportion to the K R of different cables when the very same relay arrangement is used in all cases. Concerning the relay performances at the station of the Great Northern Telegraph Company, at Gothenburg, it is said that in this case a delicate cable relay, well adjusted and worked in the old fashion, will translate up to 30 words a minute, while the maximum speed is now increased to 120 words per minute by applying the vibrating relay, the play of the tongue between the battery contacts at the same time being greater than in the former case. The ordinary daily working speed from month to month is 90 words per minute on this circuit. The article is concluded by a mathematical appendix.—Lond. *Elec. Rev.*, August 29.

Effects of Contacts upon Telegraphic and Telephonic Currents.—DE PAUSO.—A paper in which he states that when two wires covered with oxide are in contact, telephonic conversation is not interfered with; and when the oxide is thick enough the alternate currents from a

magneto are also obstructed by it. He views the oxide of copper as a dielectric, for both undulatory and alternating currents. He quotes a case on the line from Brussels to Paris, where, during a contact telephonic communication was good, but telegraphic indifferent. A similar effect was noticed during a heavy frost, when the wires were in contact between Leuze and Tournai. The frozen particles acted as a dielectric in the one case and as a conductor in the other. In the discussion which followed, several speakers quoted cases where telephonic circuits, even 7 km. in length, laid on ice or dry snow, have been successfully operated. Here the insulating property of snow and ice comes into play.—*Soc. Belge. Elec.,* Bull 19; abstracted in *Science Abstracts,* August.

REFERENCE.

Common Battery.—KELSEY.—An illustrated article, in which he discusses several points in different common battery systems.—*Telephony,* September.

MISCELLANEOUS.

Electric Response of Living and Dead Matter.—J. C. BOSE.—An account of experiments in which he continues his attempts to co-ordinate the phenomena of living and dead matter. As the most general and delicate sign of life is the electric response, he reproduces the various forms of the electric response to stimulus in animal, vegetable and mineral matter. A nerve, a vegetable fibre and a wire show similar responses to mechanical shock when stretched between two unpolarizable electrodes. Platinum and some other metals also show "fatigue," *i. e.,* the diminution of the reaction on repeated application. In other cases again, there is increased reaction. The effect of heat is the same in animal and vegetable tissue, as it reduces the reaction and eventually kills the tissue, *i. e.,* makes it incapable of response. The "stimulating" effect of sodium carbonate upon the response of platinum and the "poisoning" effect of potash or oxalic acid upon tin are striking analogies, and so is the stimulating effect of a small dose of a substance, which in larger quantities acts as a poison. "It now remains for the author to finally dispose of vital force by restoring the capacity of response in dead animal or vegetable matter, as it can be restored in metal."—*Jour. de Phys.,* August; abstracted in Lond. *Elec.,* August 22.

REFERENCES.

Biography.—A biographical sketch, with portrait, of James Swinburne, the present president of the (British) Institution of Electrical Engineers.—Lond. *Elec. Rev.,* August 1.

Manufacturing Plant.—THOMPSON.—An illustrated article on the Schenectady works of the General Electric Company.—*Am. Mach.,* September 4.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Secretary, Ralph W. Pope, 95 Liberty Street, New York. Next meeting, Sept. 26. Paper by B. G. Lamme, "The Washington, Baltimore and Annapolis Single-Phase Railway." Oct. 24, paper by C. P. Matthews on "An Integrating Photometer for Glow Lamp and Sources of Like Intensity."

AMERICAN STREET RAILWAY ASSOCIATION, Secretary, T. C. Penington, 2020 State Street, Chicago, Ill. Next meeting, Detroit, Mich., Oct. 8, 9 and 10, 1902.

INDIANA ELECTRICAL ASSOCIATION, Secretary, Hal. C. Kimbrough, Muncie, Ind. Next meeting, Indianapolis, Sept. 17 and 18, 1902.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS, Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Richmond, Va., Oct. 7, 8 and 9, 1902.

Lincoln Power House, Boston Elevated Railway.

IN our issue of June 15, 1901, a general description was printed of the Boston Elevated Railway, which was supplemented by an article by Mr. F. H. Shepard, on August 10, following, on the operating features of the road. Recently in our issue of June 7, a description in detail appeared of the Charleston power house, and we are now enabled to present a similar description of the Lincoln power house, in which a third large unit has lately been installed.

The Lincoln power house differs in many respects from the various other power houses of the same railway system. It is located on the lot known for many years as Lincoln Wharf, on the water front of Boston Harbor, and in the heart of the old city, near the junction of Commercial Street and Atlantic Avenue, where there are excellent facilities for the docking of coal and other supplies. The general appearance of the building is imposing, the architectural design being notably fine. The massive chimney, extending to a height of 250 feet, and one of the first things to catch the eye, is said to be the tallest stack in the city. The building is divided into two longitudinal sections, the boiler room and all apparatus pertaining thereto being in one section, and the engines, generators and condensing system in the other. The engine room is served by a large electric crane of 40-tons capacity. The walls of this room are faced with white enamel brick, adding much to its general appearance and illumination.

The present station contains three units, aggregating about 13,500 hp. While it is now complete in itself, ample ground area has been provided for the extension of the building and plant on harmonious lines to accommodate four additional units, thus permitting an ultimate equipment of about 30,000 hp.

The boiler installation consists of eight 468-hp and four 490-hp Babcock and Wilcox boilers. An equipment of Roney mechanical

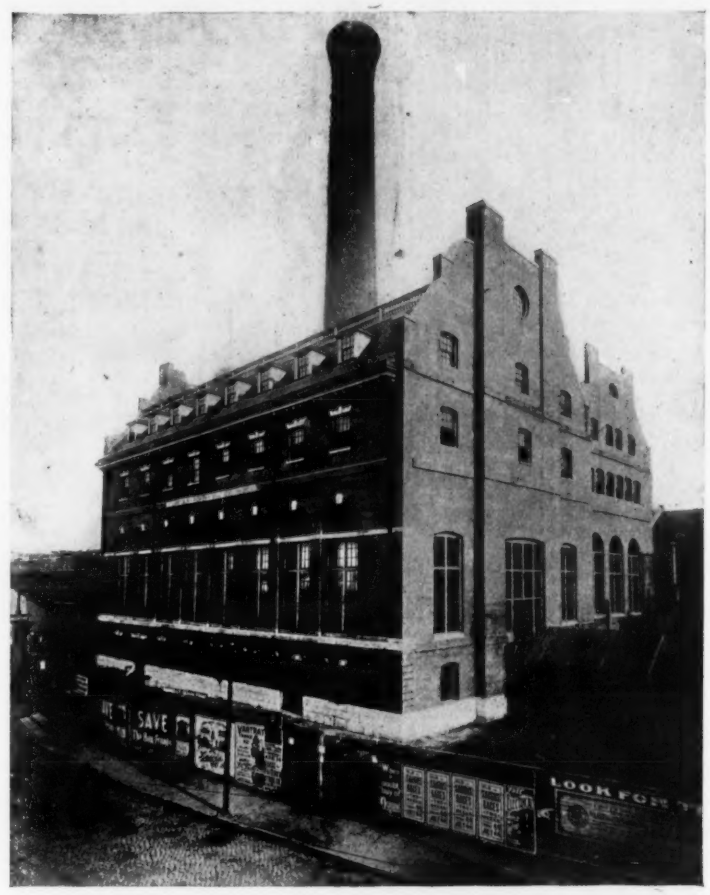


FIG. 1.—EXTERIOR OF LINCOLN POWER STATION.

stokers of the same type as those in the large power houses in New York City has been installed by Westinghouse, Church, Kerr & Co.

Coal will be automatically unloaded from vessels and stored in a large pocket holding 5,000 tons, with a further storage bin of 3,000 tons in the boiler house, or a total storage capacity of 8,000 tons. It is carried to the boilers by a Hunt coal and ash conveying system, which conducts the coal into overhead conveyors leading to the stokers, thus practically eliminating all manual labor in the handling of coal and ashes. The coal apparatus is so arranged that coal can be taken from the pocket to the storage bin in the boiler house and, in addition, tracks are located on either side so that coal cars can be automatically loaded to carry coal to the various other stations if desirable, viz., to the Charleston, Harvard, Allston and Central Stations, as well as to some thirty or more car houses situated in different parts of the city. The plant is equipped with Green economizers.

Feed water is supplied to the boilers by means of two vertical compound pumps, manufactured by the George F. Blake Manufacturing Company. A Star vacuum feed-water heater of 8,000-hp capacity is placed on the base of the chimney conveniently near the feed pumps. As the smoke flues from the boilers enter the stack at a point some

30 feet from the boiler room floor, the space in the lower part of the stack has been found quite valuable for the location of such auxiliaries as feed-water heaters, receiver of the Holly gravity return system, and sundry piping.

The original engine installation consisted of two vertical cross-compound units, of 4,500 hp each, built by the Providence Engineering Company. The generators and flywheels are carried on the shafts

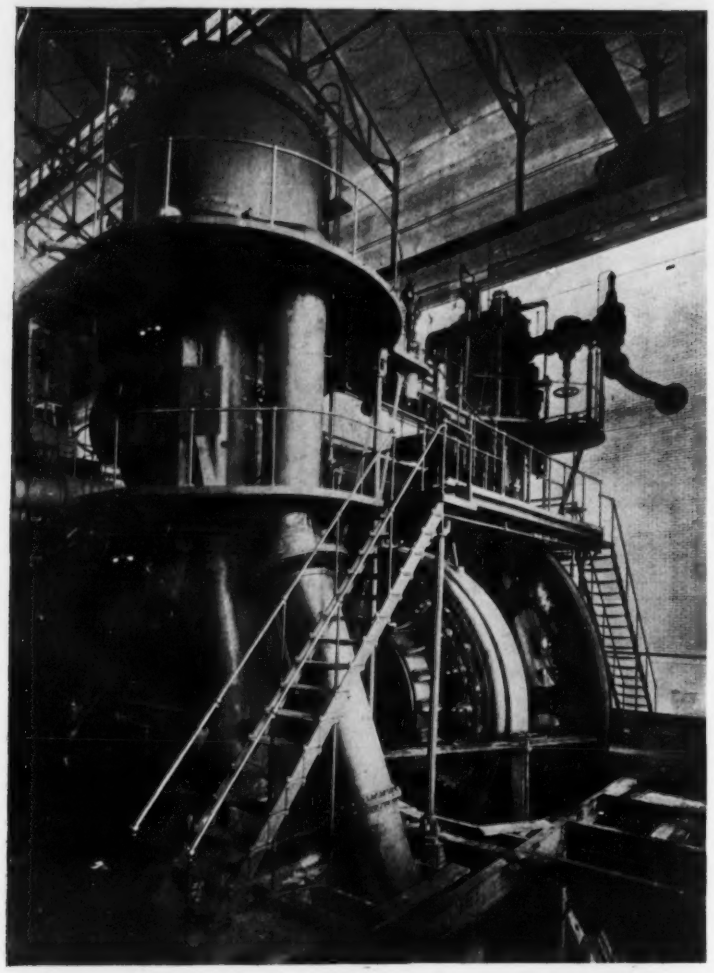


FIG. 2.—4,500-HP ENGINE DIRECT CONNECTED TO 2,700-KW GENERATOR.

between the high-pressure and low-pressure sides. The generators are direct-current machines, rated at 2,700-kw each. A third unit, which has just been completed, consists of a vertical cross-compound engine of about 4,500 hp, designed and built by the Westinghouse Machine Company, and installed by Westinghouse, Church, Kerr & Co. It is of the same design as the one recently furnished for the Charleston Power Station, and is direct connected to a Westinghouse direct-current generator of 2,700-kw capacity of the same make, and similar to one of the two machines mentioned above. The engine, however, differs considerably in design and construction from the two engines first installed. The high-pressure cylinder is fitted with poppet valves, for use with superheated steam, which is supplied by superheaters built by the Babcock & Wilcox Company.

This station is built upon land situated in the center of Boston's most desirable wharf property, and the cost of the location was, presumably, high. Had it been necessary to use other than vertical engines, the amount of land required in such a valuable locality would have given rise to a serious financial problem.

The steam piping represents all that is modern in this important portion of the plant. Steam is conveyed from both sides of the boiler room by 8-inch mains, to a 16-inch drum from which it is conducted by 12-inch risers to Cochrane receiver separators, and thence to the engines. All the live steam drips from steam drums, separators and reheating receivers are carried back to the boilers by the steam loop and Holly gravity return system.

Ingersoll-Sergeant air compressors, each driven by a 50-hp Westinghouse, 500-volt motor, supply compressed air for the block signal and switching system, used by the road. Early in the conception of the scheme of running trains at high speed under the rather complex conditions there existing, the engineers of the Boston Elevated Railway realized that a block system was necessary as a safeguard against accident. After careful consideration, the Westinghouse electro-pneumatic interlocking system, manufactured by the Union Switch and Signal Company, of Swissvale, Pa., was chosen. There were many reasons for this decision, among them being the quality and reliability of the material furnished and, again, the small space required for switch towers, signals and operating mechanism.

The elevated road includes some 14 miles of trackage. The switches and signals are controlled from four switch towers, and the automatic block signals are located at distances of about 800 feet apart. Each tower is supplied with indicators, showing the approach of trains. The towers at the junction of the Atlantic circuit and main line control some 1,200 elevated trains daily. The largest tower is located at the Sullivan Square terminal, where some 500 elevated trains and 700 surface cars pass in and out daily, involving 6,000 switch and signal movements. A force of only two men on duty is required to operate the switchboard mechanism, consisting of 35 pneumatic levers. The terminals are also supplied with lamp indicators, showing the relative location of approaching trains. While the train movements at Sullivan Square are not so complicated as those at the Boston South Terminal Railway Station, the Elevated Railway Company has less track room at its disposal and handles a much larger number of trains for a given number of tracks.

High Torque Induction Meter.

In all the types of motor meters, theory requires that the torque, speed and load should all increase in the same proportion. This is not possible, however, for the reason that torque has two factors, namely, the generation of foucault currents in the damper, which varies according to the law of the perfect meter, and the overcoming of friction, which does not vary according to such law. It is, therefore, evident that the higher the torque with a given friction, the smaller will be the deviation from the law. This principle is employed in the Thomson high-torque induction meter, made by the General Electric Company, which is shown in the accompanying illustrations. In this case the torque is made a maximum, while at the same time the utmost care has been taken to reduce the friction to a minimum. Moreover, similar care has been taken in the design and construction to insure that a meter shall not only be reasonably

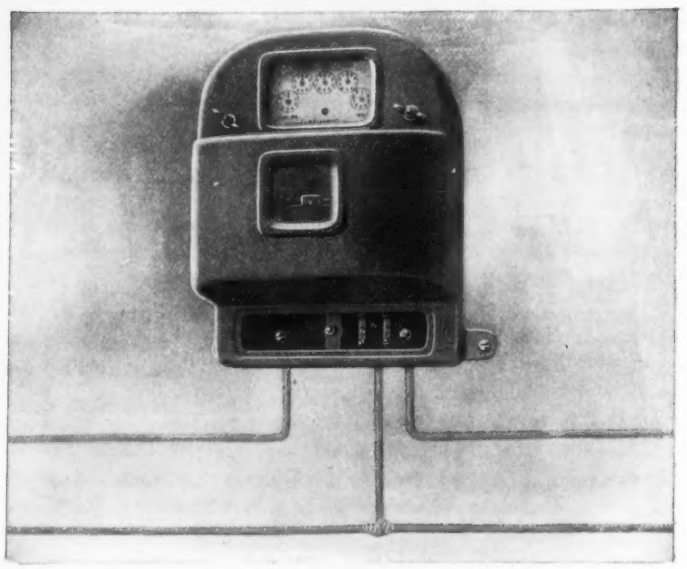


FIG. 1.—INDUCTION METER.

accurate under all reasonable conditions, but shall remain accurate and retain its value over a long period of years.

The static portion of the meter elements occupies the back of the case, and is magnetically separated from the damping magnets and shaft mechanism by a magnetic shield, shown in Fig. 2. This magnetic shield serves jointly with the iron case and cover to completely protect the damping magnets from any stray fields incident to heavy load or short-circuits which might otherwise tend to weaken the damping magnets and impair the accuracy. This shield also plays an important part in the general behavior of the meter.

The case of the meter is removed directly towards the front, as shown in the illustration. It is made of cast-iron, finished in black enamel, and rests against the back frame upon felt packing, to which it is securely bound by two wing nuts, both of which may be sealed.

The register is of the new "no constant" type, having five indicator hands, as on all Thomson recording wattmeters. The readings are uniform with the readings of the Thomson recording wattmeters, and may be recorded and tabulated on the same system.

The binding-posts are located at the bottom of the meter, and are so arranged as to render installation easy and rapid. A small cast-iron lid covers an oblong aperture in the base of the meter case, and is held in place by a wing nut. This lid, when removed (Fig. 1), exposes the binding-posts and gives access to them without in any other way opening the meter.

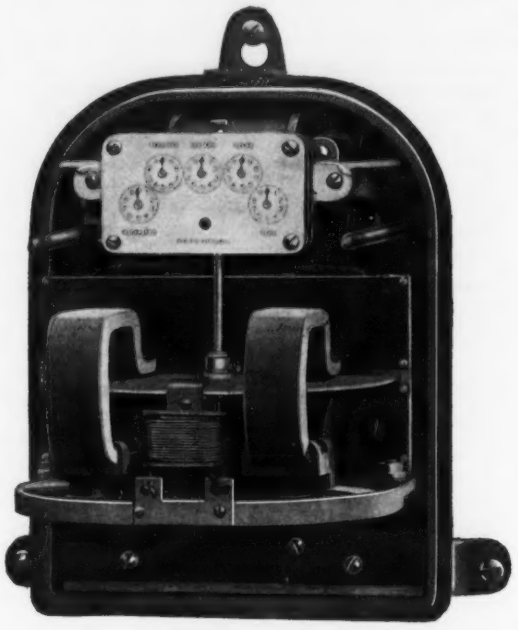


FIG. 2.—VIEW OF METER MECHANISM.

As friction is a variable, it is important to provide means for easily and immediately compensating for friction. The high-torque meter has been provided with a device for this purpose, which is generally known as the light-load adjustment. This device consists of a small and entirely independent torque producing structure which will be noted between the magnets in Fig. 2 and in Fig. 3. This device is provided with a movable sector, which by adjustment gives complete control of friction, compensation, and light-load accuracy, without disturbing the other essential characteristics of the meter, such as accuracy on inductive load, changes of frequency, wave form, potential and the like.

The light-load adjustment device permits of a 10 per cent. speed variation plus or minus at light load without affecting general calibration.

It is conceded that accuracy on inductive loads is essential to an induction meter for general alternating-current service; the high-torque induction meter is designed and proportioned so as to secure the highest possible inductive load accuracy, and may be relied upon to record true watt hours either upon an entirely non-inductive load, such as incandescent lamps, or upon highly inductive loads, as fan, or other motors.

The meter, in common with all other meters of its class, must be proportioned and calibrated for the frequency upon which it is to be used. In view of the fact that 125 cycle systems are now quite generally being converted to 60 cycles, all high-torque induction meters ordered for use on 125 cycle systems are provided with means for immediate reconnection for 60 cycle service, to provide for a possible future change. Meters ordered for 60 cycle service, however, are not provided with this feature, as it constitutes in that case an unnecessary complication.

It is probably not generally appreciated that the principle of the induction meter renders it especially sensitive to variations of wave form, but great care has been exercised in the design of the high-torque meter to secure satisfactory behavior in this particular.

A large proportion of central-station systems of moderate size have appreciable variation of potential from the normal potential of the system, either on different portions of their lines or during different portions of the 24 hours. It is, therefore, highly important that the meters used on such a system should be accurate irrespective of such potential variations. This characteristic may readily be determined by test, and constitutes an important consideration. The high-torque meter is unaffected by a 10 per cent. variation in voltage, either side of that for which it is calibrated.

Minute attention is given to the matter of producing reliable magnets. Each shipment of steel from a manufacturer is assigned a distinguishing symbol, and immediately upon receipt, a certain portion of it is put through special processes, is formed, hardened, magnetized and aged, and complete measurements are made at each step. Upon the results of these measurements is based the acceptance or the rejection of this particular shipment. If rejected, the remainder of the shipment, together with these samples, is returned to the manufacturer to dispose of as best he may. If acceptable, the remainder of the steel is put through, each magnet being stamped with the distinguishing symbol of this shipment, and the shipment is passed to production. After passing through the hardening furnaces, the magnets are subjected to hammer blows, and those failing to ring absolutely true are thrown out. They are magnetized in a machine of special construction, and are subjected to numerous processes of artifical aging, the most essential of which are patented. The magnets are then carefully measured and stored in individual trays for a period of time, after which those magnets which do not measure exactly as when laid aside are discarded.

A long and thorough investigation has demonstrated that there is but one grade of sapphire for jewel-bearing stones which is satisfactory for service in connection with motor meters. It is a certain grade of Eastern sapphire, which must be cut and polished with the greatest care. The General Electric Company buys and uses Ceylon sapphires only, and rejects a large percentage of the total purchases. As an additional precaution, the stone is bought in the pebble, selected by an expect lapidary, and is cut and polished in the company's factory.

In the manufacture of jewels from sapphire, it is possible to polish them only by the use of diamond dust, which is carried in a heavy oil for convenience of application. This diamond dust is graded according to the number of hours required to precipitate it from the oil in which it is carried. The precipitate, which will polish a perfectly hard stone in a satisfactory manner, is sufficiently rough to cut and scratch a soft stone. By using only that precipitate which is sufficiently coarse to cut soft stones, an additional inspection is secured, for the workman finds it impossible to polish any stone which is not of the higher grade of hardness.

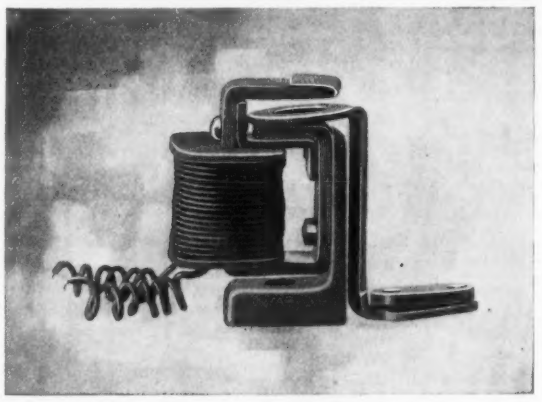


FIG. 3.—DEVICE FOR PRODUCING TORQUE.

The exact strength of the supporting spring beneath the piston of the jewel mount in relation to the weight of the moving element of the meter is a highly important factor in the life of the jewel. The strength of this spring is, therefore, the subject of careful test and inspection in connection with every complete jewel screw issued. The strength of each spring is carefully gauged by high and low limit weight, and all springs not falling within the proper limits are rejected.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The disturbances in the loan market caused call money to advance as high as 20 per cent on Friday, closing, however, at 6 per cent. nominal. The closing rate for 60 days' loans was 6 per cent. The stock market retained a bullish undertone, but prices receded and speculative activity showed a decrease, owing to the advance in call loan rates and in the diminished supply of money in the market. The steel stocks were quite firm, but incipient activity in the industrial division was checked by higher money. Greater attention was paid to industrials as a class, although they continue to be subordinate to the railroad share list. The traction stocks were neglected in spite of talk about the increased earnings by the Brooklyn Rapid Transit. In Boston there was some excitement in coppers, but at the close of the week quiet again prevailed in that market. Brooklyn Rapid Transit after reaching 72 closed at 68½, being a net loss of 6 points. General Electric ranged between 191¼, the lowest, and 195, closing at 192, a net loss of 1½ points. Metropolitan Street Railway was quiet, closing at 147, a net loss of 1 point. Western Union closed with a net gain of 1⅛ points, the alleged pool showing a tendency to support that stock more effectually. Prices ranged between 95 and 97, the closing figures being 95⅞. Westinghouse closed at 228, a net gain of 2 points, the highest quotation of the week being 233; and American Telephone and Telegraph at 170, being a net loss of 2 points. Commercial Cable made a gain of 11½ points, closing quotation being 174½. Following are the closing quotations of September 16:

NEW YORK.

	Sept. 9	Sept. 16.		Sept. 9	Sept. 16.
American Tel. & Cable.	—	—	General Electric	195	192
American Tel. & Tel.	171½	170½	Hudson River Tel.	—	—
American Dist. Tel.	—	—	Metropolitan St. Ry.	147¾	145½
Brooklyn Rapid Transit	71	68⅝	N. E. Elec. Veh. Trns.	1	—
Commercial Cable	174½	—	N. Y. & N. J. Tel.	—	—
Electric Boat	25	25	N. Y. E. V. T. Co.	11½	11½
Electric Boat pfd.	40⅛*	40	Tel. & Tel. Co. Am.	—	—
Electric Lead Reduc'n.	2⅜	2⅛	Western Union Tel.	96⅛	95⅞
Electric Vehicle	5¾	5¼	West. E. & M. Co.	—	227
Electric Vehicle pfd.	15¼	15	West. E. & M. Co. pfd.	—	—

BOSTON

	Sept. 9	Sept. 16.		Sept. 9	Sept. 16.
American Tel. & Tel.	171	170¼	Western Tel. & Tel. pfd.	100½	100¾
Cumberland Telephone	—	128	Mexican Telephone	2¼	2¼
Edison Elec. Illum.	—	—	New Eng. Telephone	142	141¾
Erie Telephone	—	—	Westinghouse Elec.	—	112½
Western Tel. & Tel.	29¾	29½	Westinghouse Elec. pfd.	—	112½

PHILADELPHIA.

	Sept. 9	Sept. 16.		Sept. 9	Sept. 16.
American Railways	53	52	Phila. Traction	100	98¼
Elec. Storage Battery.	89½	89¼	Phila. Electric	9 1/16	8¾
Elec. Storage Bat'y pfd.	88½	88	Pa. Elec. Vehicle	—	—
Elec. Co. of America.	9⅜	9½	Pa. Elec. Vehicle pfd.	—	—

CHICAGO.

	Sept. 9	Sept. 16.		Sept. 9	Sept. 16.
Central Union Tel.	—	—	National Carbon pfd.	100	100½
Chicago Edison	—	175	Northwest Elev. com.	—	—
Chicago City Ry.	222*	217	Union Traction	18¾	18
Chicago Tel. Co.	—	—	Union Traction pfd.	50	47
National Carbon	34*	33			

*Asked.

WESTERN UNION.—The Western Union Telegraph Company issues the following statement for the quarter ending September 30, 1902, the figures for the current year being partly estimated, while those for 1901 are actual:

	1902.	1901.	Changes.	
Net revenue	$2,100,000	$1,949,316	Inc.	$150,684
Bond Interest	252,550	239,040	Inc.	13,510
Balance	$1,847,450	$1,710,276	Inc	$137,174
Dividends	1,217,110	1,217,005	Inc.	105
Surplus	$630,340	$493,271	Inc.	$137,069
Previous surplus	10,751,003	9,319,285	Inc.	1,431,718
Total surplus	$11,381,343	$9,812,556	Inc.	$1,568,787

The actual returns for the quarter ended June 30, 1902, were: Net revenue, $1,892,476; bond interest, $254,770; balance, $1,637,706; dividends, $1,217,008; surplus, $420,698; previous surplus, $10,330,305; total surplus, $10,751,003. The directors of Western Union have declared the regular quarterly dividend at 1¼ per cent., payable October 15, to stockholders of record September 20.

EDISON ELECTRIC COMPANY, LOS ANGELES.—It is proposed, as already noted, to reorganize the Edison Electric Company of Los Angeles, Calif., in order to increase the company's capital stock to $10,000,000. The reorganization contemplates the exchange of securities in the present company for an equal amount of new preferred stock with 20 per cent. of the new common stock added, merging the present Edison Company with the Redlands Light and Power Company, Santa Ana Gas and Electric Company, Pasadena Electric Company and other Edison subcorporations. The new stock will be divided into $4,000,000 preferred and $6,000,000 common, $2,000,000 of the preferred and $400,000 of the common stock to be issued at once, and the remainder to be held in the company's treasury. It is contemplated in the proposed reorganization to create a $10,000,000 five per cent. gold bond issue, which is already pledged to be taken by a syndicate of Chicago, San Francisco and New York bankers. Bonds of the old parent company and subcompanies will be retired. The new fund will be used for the construction of a 20,000-hp hydro-electric plant on Kern River, with transmission lines to Los Angeles; the erection of a steam plant in Los Angeles for reserve purposes, and similar plants on Mill Creek and Santa Ana River.

DIVIDENDS.—The Philadelphia Traction Company has declared the regular semi-annual dividend of $2 a share, payable Oct. 1. The Chicago South Side Elevated has declared the regular quarterly dividend of 1 per cent., payable Sept. 30. The directors of Detroit United Railway have declared the regular quarterly dividend of 1 per cent., payable October 1. The Louisville Railway directors will declare a dividend on the common stock January 1, and will place it on a 5 per cent. basis. The company will also issue $500,000 of new common stock at $50 a share, similar distributions to be made the next two years. The regular quarterly dividend of 1 per cent. on the common stock of International Steam Pump is payable October 1.

NORTHERN OHIO TRACTION COMPANY.—The plan for refinancing the Northern Ohio Traction Company, at Cleveland, contemplates the organization of the Northern Ohio Railway and Light Company, with a bond issue of $7,000,000 and a capital stock of like amount. Improvements to the system will be made at a cost of $500,000.

BELL TELEPHONES.—An increase of 3,098 instruments is reported in the net output of the American Telephone and Telegraph Company for the month ended August 20, making a net increase of 90,182 instruments since December 20 last.

Commercial Intelligence.

THE WEEK IN TRADE.—Fall trade is still expanding in volume, reports of unabated activity coming from all sections. Industry is active, and present outputs equal and in most cases exceed reports, except in the hard-coal region and iron and furnace work, the latter because of the coke shortage. Railway earnings were rather more irregular because the season of grain movement is somewhat later, and strikes are reflected in decreases on some roads; but excluding the hard-coal roads, the month of August shows 5 per cent. gain in the gross receipts over last year. The anthracite coal strike appears to be fading away, some other strikes have been actually ended, and labor is well employed as a rule. Building material is brisk, and in the East, where quiet prevailed of late, there is an active call for lumber. The shortage of fuel still aggravates the iron situation, which keeps the flood of foreign iron and steel steadily rising; the July import is not far from 100,000 tons. Rails and structural materials are still the prominent features, and trade in wire is improving. Hardware is in excellent demand everywhere. Copper is stronger in tone. There was a short-lived boom on Friday as a result of which producers reaped a handsome profit by making large sales, and even exporters who purchased copper previously for export at low prices resold it in this market at a good profit. Lake sold as high as 12¼c.; electrolytic brought 11⅝c. to 12c., and casting 11½c. to 12c. There was a slight reaction at the close of the week, the final prices being 11.80c. to 12.25c. for Lake, spot to December; 11.75c. to 11.90c. for electrolytic and casting, and 11.20c. to 11.60c. for standard. The business failures for the week ending September 11, as reported by *Bradstreet's*, aggregated 197, as against 133 the week previous, and 182 the same week last year.

PORTO RICO WATER-POWER PROJECT.—A scheme is on foot for the purpose of taking advantage of the most important water power in Porto Rico. The project includes the building of a dam and power house on the Rio Plata, located in the mountains, about 17 miles distant from San Juan; the construction of a transmission line from the hydraulic plant to San Juan, and the construction and equipment of a substation in that city; the furnishing of a ferryboat to run from San Juan to Catano, a small town situated across the bay, and the present terminus of a narrow-gauge steam road, which runs from Catano to Bayamon, a distance of about 4⅓ miles; and, lastly, the conversion of the above-mentioned road to a standard gauge electric traction system. Regarding the power plant, the total head, with a dam, would be 190 feet. At this head, with a minimum flow of the river, the horse-power at the end of the water-wheel shaft would be 1,600. It is proposed to equip the power house with three generators of 500-kw capacity each. Ultimately, it is proposed to build a number of storage dams with a view to increasing the capacity of the plant. The first section of the pipe line will be built of 5 feet 6 inch pipe. The second will be constructed of 5 feet size. For the third section, where the gradient is much steeper, it is proposed to use a diameter of 4 feet 6 inches. The length of the pipe line will be about half a mile. All the pipe will be steel riveted. The Luz Electrica, a San Juan lighting plant of about 800-hp capacity—5,050 incandescent lamps, of 16-cp—is to be taken over by the new enterprise, which is called the Rio Plata Electric Company, and of which George W. C. Drexel, of Philadelphia, is president, and Ramon Valdes, Edison Building, Broad Street, New York; Andrew C. Gray, Wilmington, Del.; Chas. Sinkler, 501 Drexel Building, Philadelphia, and United States Engineer Cosby, of Mobile, Ala., are largely interested. The Lux Electrica plant at present is equipped with General Electric generators and Harrisburg, Payne & Westinghouse engines. The carrying out of the entire project will involve an expenditure not far short of three-quarters of a million dollars.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical materials from the port of New York for the week ended September 6: Azores—3 pkgs. material, $563. Argentine Republic—63 pkgs. material, $1,730; 2 pkgs. machinery, $42. Amsterdam—1 pkg. machinery, $72. British West Indies—75 pkgs. material, $3,024; 210 pkgs. machinery, $11,386. British Guiana—23 pkgs. material, $521. Bremen—76 pkgs. material, $2,268. British Australia—49 pkgs. machinery, $4,524; 251 pkgs. material, $6,014. British Possessions in Africa—4 pkgs. material, $102. Bristol—22 pkgs. material, $16. Brazil—18 pkgs. material, $1,224; 82 pkgs. machinery, $27,797. Berlin—1 pkg. machinery, $715; 19 pkgs. material, $748. Chili—37 pkgs. material, $1,935. Cuba—33 pkgs. material, $11,825. Central America—19 pkgs. machinery, $400; 26 pkgs. material, $254. Dutch West Indies—10 pkgs. machinery, $1,705. Dover—1 pkg. material, $22. Ecuador—67 pkgs. material, $396. Fiume—12 pkgs. machinery, $4,800. Gilbraltar—1 pkg. material, $50. Genoa—2 pkgs. material, $103. Glasgow—2 pkgs. material, $81. Hamburg—4 pkgs. machinery, $337; 8 pkgs. machinery, $314. Hayti—7 pkgs. material, $80. Havre—9 pkgs. material, $190; 1 pkg. machinery, $40. Japan—6 pkgs. machinery, $1,940. Leicester—2 pkgs. material, $65. London—12 pkgs. machinery, 12,653; 54 pkgs. material, $3,649. Liverpool—148 pkgs. machinery, $17,448; 97 pkgs. material, $4,440. Newcastle—7 pkgs. machinery, $1,100. Mexico—1 pkg. machinery, $799; 7 pkgs. material, $254. Milan—2 pkgs. material, $45. New Zealand—8 pkgs. machinery, $410; 15 pkgs. material, $356. Peru—11 pkgs. material, $245. Southampton—102 pkgs. material, $1,528. U. S. Colombia—3 pkgs. material, $45; 7 pkgs. machinery, $3,750.

THE RAILWAYS AND LIGHT COMPANY OF AMERICA, whose executive offices are in the Continental Trust Bldg., Baltimore, Md., has recently opened in addition a general manager's office in the Shafer Building, Richmond, Va. This office is in charge of Mr. E. L. Bemiss, who has recently been appointed general manager of the company, in place of Mr. E. C. Hathaway. Mr. Bemiss was formerly with the Richmond Traction Company. Mr. Hathaway has been appointed general manager of the Norfolk, Portsmouth and Newport News Company, with offices at Norfolk. This company is one of the consolidations effected and operated by the Railways and Light Company of America. It comprises railway, electric and gas lighting and ice manufacturing interests, and is a consolidation of 14 former companies, operating in Berkeley, Newport News, Portsmouth, Hampton Roads, Old Point Comfort and Norfolk. Mr. Berkeley Williams, who was formerly purchasing agent of the Richmond Traction Company, has been made purchasing agent of the Railways and Light Company of America, with the idea of making blanket contracts to cover all the properties owned and operated by it. Mr. John Pope has recently accepted a position on the engineering force. Mr. Pope was formerly with the Virginia Electrical Developing Company.

ANOTHER MEXICAN POWER PROJECT.—The North American Beef Company, composed of Chicago capitalists, intends to erect a huge water-power plant at Uruapam, in the State of Michoucan, Mexico, for the purpose of operating a $500,000 packing plant there and supplying the cities of Morelia and Acambaro, also the mines of the El Oro with power for general purposes. C. Mallory, of Chicago, until recently a member of the Mallory Commission Company, and now president of the Mexican Plantation and Steamship Company, is primarily interested in the North American Company. Other parties concerned include W. Ball, of the Chicago Board of Trade; Judge Holmes, attorney of the Union Traction Company, and Judge Palmer. It is proposed in the first instance to construct a hydraulic plant of about 3,000 hp capacity. Eventually it is intended to increase the equipment up to 5,000 hp for the purpose of operating large tanneries, candle and soap factories and other industrial plants which the company intends to establish in the near future.

BROOKLYN SUBWAY AND WIRES.—The Board of Estimate of Greater New York met last week and authorized a bond issue of $3,000,000 for the Brooklyn tunnel extension. The contract for the Brooklyn extension from the rapid transit subway at City Hall, Manhattan, down Broadway and under the East River to Brooklyn, was signed on Thursday, and within twenty-four hours the money for the work was appropriated. Commissioner Monroe, of the Department of Water Supply, Gas and Electricity offered a resolution that in Brooklyn trolley feed wires and all others except those now securely attached to elevated structures on several of the most traveled thoroughfares in Brooklyn be put underground. Prof. Colin, of the Brooklyn Rapid Transit Company, objected to the passage of the resolution on the ground that is was unnecessary. The resolution suggested by Commissioner Monroe was adopted.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, of Chicago, has just closed a contract with the Keystone Telephone Company, Philadelphia, for two more common battery multiple relay switchboards, of 4,800 lines capacity each, for its fifth and sixth district exchanges, respectively. Included in this contract is a chief operator's desk, wire chief's desk and manager's desk, all of which will be of mahogany, to match the main switchboard, together with all necesary power apparatus, relay racks, distributing frames, lightning arresters and sneak-current apparatus. This will make a total ultimate equipment of 34,080 switchboard lines, which the Kellogg Company will have furnished the Keystone Telephone Company for its extensive system in Philadelphia.

POWER PLANT IN INDIANA.—Plans are well under way for the construction of a large electric power plant at Horseshoe Bend, eight miles south of Monticello, Ind. A tract of 40 acres at this point on the Tippecanoe River has been purchased by Charles Meeker and other Lafayette capitalists. It is proposed to furnish electricity for power and lighting to Delphi, Lafayette, Monticello and other neighboring towns, and for the proposed electric railway along the old Wabash canal.

NEW POWER PLANT IN CONNECTICUT.—The Connecticut Railway and Lighting Company has asked for bids on plans for three new buildings which will be erected by the company in Shelton, New Britain and Waterbury. To erect these buildings, an amount close to $200,000 will be expended. In Shelton, the company will erect an entirely new power plant and another one in New Britain. In Waterbury a large addition to the present power plant will be constructed.

A. B. SEE ELEVATOR WORKS.—The A. B. See Electric Elevator Company, factory at 116 Front Street, Brooklyn, has bought more than eight acres on Pacific Avenue, Pine and Carnoth Streets, Jersey City, and will erect works there, moving from Brooklyn. The new buildings are to cost $70,000. The concern has done a large and growing electric elevator business for many years past.

LIGHTING PLANTS.—The Steam & Electrical Equipment Company, Conestoga Building, Pittsburgh, has received orders from the Poughkeepsie Light, Heat & Power Company, of Poughkeepsie, N. Y., for one 190-kw Stanley, 60-cycle two-phase 2200-volt alternator, and from the Waynesburg Electric Light, Heat & Power Company for a Babcock & Wilcox 108-hp boiler.

MR. G. M. GEST, the well-known conduit contractor, has recently secured the contract for the conduit system for the Schenectady Railway Company, Schenectady, N. Y. This work will amount to over 2,000,000 feet. It is Mr. Gest's intention to make this installation a model one in every respect. Many new features will be designed for this particular installation.

ANOTHER ELECTRIC ROAD FOR TAMPICO.—An electric traction system is to be constructed in the City of Tampico, Mexico, to connect with the docks at Dona Cecilia and the mouth of the Panuco River. The total length of the lines will be a little over seven miles.

BUNNELL INTERESTS CONSOLIDATED.—It is stated that a consolidation has been effected of the Bunnell interests in the electrical manufacturing field, Mr. Morris Wise, of the Bunnell Telegraphic and Electrical Company, having bought out J. H. Bunnell & Co. from Mr. C. McLaughlin. Details are not yet forthcoming.

General News.

THE TELEPHONE.

SANTA BARBARA, CALIF.—An application for a telephone franchise for the Santa Barbara Home Telephone system has been made by C. F. Guthridge. The system is to be connected with those of the home company of Los Angeles and other southern California cities. The company offered to give the city two per cent. of the gross earnings and a certain number for free telephones. It is said that $50,000 will be spent in installing the plant, and local rates will be reduced.

DENVER, COLO.—The People's Telephone Company has been incorporated with a capital of $200,000, by R. J. Bolles, J. T. Sanger and S. H. Benton. Lines will be built in El Paso, Arapahoe, Boulder, Clear Creek, Gilpin, Jefferson, Fremont and Custer Counties.

SELBYVILLE, DEL.—The Selbyville Telephone Company has been incorporated; capital $50,000. Incorporators: John G. Townsend, Jr., Isaiah W. Long and Isaiah J. Brozure, all of Selbyville.

DE LAND, FLA.—The town of De Land has granted a franchise to M. G. Rowe, of Starke, for a telephone system in De Land.

JACKSONVILLE, FLA.—On Oct. 1 the Southern States Telephone and Telegraph Company will apply for a charter. The capital stock will be $500,000. The company proposes to cover many hundred miles, connecting Jacksonville with other towns in the State. W. S. West will be president of the new company.

WAYCROSS, GA.—The Southern Telephone Company, of this city, has been sold to the Southern Bell Telephone Company. Some time ago the city council of Waycross refused to grant the Bell Company a charter to operate in this city and that company had to run its long distance wires around the city and established its station outside the city limits. It is said that unless the city council grants the Bell Company a new franchise, it will continue to operate the old system as heretofore.

CULDESAC, IDA.—The Nez Perce Co-operative Telephone Company will build a line from Ilo to Dublin and thence to Mohler by way of Fletcher.

CARMI, ILL.—The White County Telephone Company has been incorporated by J. C. Stokes, G. P. Hanna and T. H. Land. Capital, $9,000.

CHICAGO, ILL.—The Illinois Telephone Company's downtown tunnel is rapidly nearing completion, despite the City Council's non-action. It is said the downtown conduits will be finished by Dec. 1, and that by Feb. 1, 10,000 instruments will be in service.

CHICAGO, ILL.—Long distance telephone connection is to be established between Grand Marais and Whitefish Point, Lake Superior. This will be of great service to life-savers in case of disaster, and also will aid the weather bureau in the display of storm signals.

WINDSOR, ILL.—The Windsor Mutual Telephone Company contemplates making some extensions of its lines into the country. It has just been organized. Its switchboard has a capacity of 100 drops, the apparatus used being of Stromberg-Carlson make. The service is conducted on the "mutual plan."

HYMERA, IND.—The Hymera Telephone Company, of Sullivan County, has been incorporated. The capital stock is $5,000. The company will construct and operate a telephone system in Hymera, and subsequently extend the service throughout the county. The directors are: James M. Barnett, O. B. Kattman, H. F. James, J. G. Barnett and John Funkhouser.

MILFORD, IND.—The Royal Telephone Company, of Kosciusko County has been incorporated with a capital of $20,000. The company will construct and maintain a telephone system in Kosciusko County with a central exchange and office at Milford. The company proposes to extend its service to adjacent counties. John W. Whitehead, James Haller, G. G. Grady, M. O. Whight, P. T. Miller and W. B. Neff constitute the board of directors.

INDIANAPOLIS, IND.—Complete figures compiled from the record of the recent session of the State Tax Board, show a large increase in the assessment or valuation of tangible telephone property over last year. In 1901 the telephone companies were assessed for a valuation of $4,436,666, exclusive of real estate; and in 1902 $5,065,323.30, an increase of $628,660.30. Telegraph companies in 1901, $2,514,812.00; 1902, $2,478,183.50, a decrease of $36,625.50.

INDIANAPOLIS, IND.—The New Long Distance Telephone Company has filed in the recorder's office a mortgage for $1,000,000 in favor of the Union Trust Company, of Indianapolis, to secure payment on 1,200 gold-bearing five per cent. bonds, payable in twenty years. The bonds are for $1,000 and for $500. The mortgage covers all the tangible property of the company in thirty-two counties of the State, a copy of the mortgage being placed on record in each county. The money will be used for the general improvement and extension of the service, to improve the system. The lines will be extended into other counties as soon as possible.

FRANKFORT, KY.—The Maysville & Vanceburg Telephone Company of Lewis County has been incorporated, with a capital of $2,500, by A. J. Stein, of Vanceburg, J. W. Chambers, of Winchester, and others.

BALTIMORE, MD.—The Maryland Telephone Company of Baltimore is installing facilities to increase its plant to 12,000 subscribers.

PITTSFIELD, MASS.—The Berkshire Telephone Company has accepted the franchise in this place and will at once begin the work of establishing a telephone system.

AUGUSTA, ME.—The General Automatic Exchange, capitalized at $1,000,000, has filed its certificate of incorporation. The company was organized at Portland and will manufacture articles and materials used in building and operating telegraph, telephone and district messenger lines. The promoters are H. M. Davis and F. N. Balch, of Boston, Harry R. Virgin, Franklin C. Payson and A. C. Percy, of Portland.

MARSHALL, MICH.—The new exchange of the Marshall Telephone Company has been placed in operation with 400 subscribers. A long distance line is being built to Battle Creek to connect with Grand Rapids and points in Western Michigan. Another line has been constructed to connect with Jackson and Lansing.

DETROIT, MICH.—Mayor Maybury and a group of Detroit capitalists are prepared to work out plans to push to completion an independent telephone plant for this city. It is the plan to take over the incompleted telephone plant of the People's Telephone Company, which is owned by the Federal Telephone Company of Cleveland; also to buy out the Co-operative Telephone Company, organized by local people, and which has progressed to the extent of securing a franchise and ordering a switchboard. The People's Telephone Company offers to sell its conduits and other work installed for $400,000; $100,000 to be paid in cash, and $300,000 in the securities of the new company and to invest $200,000 in the new company's stock. The Co-operative Company is willing to sell its property for $35,000. It is stated it would cost about $750,000 to place the plant in working order and that $600,000 of this has been subscribed by the Detroit people. It is expected this deal will be closed in the near future.

NATCHEZ, MISS.—The Cumberland Telephone and Telegraph Company has been granted a franchise in this city.

COFFEEVILLE MISS.—The Cumberland Telephone Company will establish a system here, the requisite number of subscribers having been obtained.

JOPLIN, MO.—The Home Telephone Company, of this city, has filed letters of incorporation, with a capital stock of $200,000, all paid. The incorporators are Theodore Gary, J. L. Bridgeford, Ross Larrabee, Raymond E. Frey, Dan R. Hughes and John Scovern, of Macon, Mo., John W. Layne, of Carthage, W. H. Warren, George G. Bayne, G. F. Newburger and others.

ST. LOUIS, MO.—The Bell Telephone Company of Missouri will erect a new building on the southwest corner of Grand and McRea Avenues, to be known as the Grand station. The building will be a modern, slow combustion one, the exterior of which will be constructed of vitrified brick, with stone and terra-cotta trimmings, laid in Portland cement. There will be no plastering, but, instead, the entire interior of the building will be lined with enameled brick of various colors. The stairway and entrance are to be of white marble and iron, with brass trimmings and all the window frames, etc., will be made of galvanized iron and glazed with wire glass. The building will be equipped with a low pressure steam heating apparatus. Especial attention has been given toward the comfort of the employees, in providing a dining-room, kitchen, etc. When completed, this building will enable the telephone company to operate its underground system in the southern district of the city. The building will cost $30,000.

HASTINGS, NEB.—The Adams County Telephone Company (Independent) has been granted a franchise in this city, and will expend $30,000.

LAKEWOOD, N. J.—The Township Committee two years ago passed an ordinance granting the New York and New Jersey Telephone Company permission at its request to place its wires underground throughout the town. This the company has made no attempt to do. Because the company erected new poles on several of the streets last week, which is claimed to be an alleged violation of one of the sections of the ordinance passed, the Township Committee at its meeting revoked the franchise granted it. Any attempt now made to place its wires underground will probably be met by an injunction restraining it from doing so.

SAYRE, N. Y.—The Lehigh Valley Railway Company is to erect a telephone line along the Montrose branch, between Tunkhannock and Montrose.

CHARLOTTE, N. C.—The Bell Telephone Company has been granted the privilege of putting its wires underground.

SPRINGFIELD, OHIO.—The Springfield Home Telephone Company is building a line to Orchard.

ANDOVER, OHIO.—The Andover Electric Telephone Company is building a line to West Williamsfield.

HICKSVILLE, OHIO.—The Hicksville Telephone Company has increased its capital stock from $10,000 to $25,000.

KENTON, OHIO.—The Kenton Telephone Company is building copper circuits to Marion, Mt. Victory, LaRue and other towns.

RAVENNA, OHIO.—The Ravenna Home Telephone Company has leased new quarters and will remove at once. The company has 700 lines in operation.

PITTSFIELD, OHIO.—The Pittsfield Home Telephone Company has just completed the work of installing its exchange. It will build additional farmers' lines.

HAMILTON, OHIO.—The Hamilton Home Telephone Company has agreed with the city to install much of the system in the business section in underground conduits.

SALEM, OHIO.—The strike of the operators of the Columbiana Telephone Company has been adjusted and the girls have returned to work with a small increase in wages.

PORT CLINTON, OHIO.—The Port Clinton Home Telephone Company has been sold to the Ottawa County Telephone Company, which will incorporate with a capital stock of $150,000.

CLEVELAND, OHIO.—Charles Richeter, a real estate man, has brought suit against the Cleveland Telephone Company for failure to include his name in the Telephone Directory. Mr. Richeter claims he has been a subscriber for thirteen years. He claims to have lost a number of real estate transactions through failure to have his name in the book, and he demands $10,000 damages.

MANSFIELD, OHIO.—It is stated that the option on the Mansfield Telephone Company, which has been held for some time by Senator Laning, of Norwalk, has been closed and that the system will speedily pass into the hands of the Norwalk syndicate. The Mansfield stockholders will retain their minority interest, and it has been arranged to make a number of improvements to the plant.

CLEVELAND, OHIO.—An enterprising retail grocer has taken advantage of the offer made by the Cleveland Telephone Company, of one-way kitchen service for six months trial at $1, and has placed orders for two hundred

instruments which will be placed in the kitchens of patrons who have no telephones. It is believed the Cleveland Telephone Company will put in 20,000 new telephones under this plan.

CLEVELAND, OHIO.—If plans now under consideration do not miscarry, the Everett-Moore syndicate, which a short time ago was acknowledged to be the strongest factor in the independent field in this country, will soon practically retire from the telephone business. The announcement is made that in all probability 60 per cent. of the holdings of the United States Telephone Company will be sold to a syndicate of capitalists headed by Edward L. Barber. Forty per cent. of the holdings would still remain in the hands of the Cleveland people, but it appears to be the policy of the syndicate to dispose of all its telephone interests. The capitalists, among whom Mr. Barber is the leading spirit, have already constructed nearly thirty exchanges in Ohio, recently completing one in Toledo, and are now building exchanges in Louisville, Kansas City and Chicago. It is claimed that in his operations Mr. Barber is backed by interests allied with the Standard Oil Company.

CHESTER, PA.—It is learned that the amalgamation of the Keystone State Telephone Company and the United Telegraph and Telephone Company will be effected, the latter merging with the former.

HARRISBURG, PA.—Judge Weiss, in an opinion, declares that telephone companies have the right of eminent domain in Pennsylvania under the act of 1874.

PIERRE, S. D.—The Hyde County Telephone Company, of Highmore, S. D., has been incorporated with a capital stock of $1,000.

ABERDEEN, S. D.—At the annual meeting of the stockholders of the Dakota Central Telephone lines at Aberdeen, the old officers and directors were re-elected. The annual report shows that during the past year $120,000 has been expended in extensions, improvements and general equipments. One thousand miles of new lines have been constructed and seven exchanges bought, including the Aberdeen exchange. Several important improvements are now contemplated, especially in the way of constructing copper metallic circuits on the more important lines of the company.

FORT MILL, S. C.—S. L. Meacham has been granted a franchise for a telephone system in Fort Mill.

CLARKSVILLE, TENN.—The Clarksville Home Telephone Company, capital stock $100,000, has been incorporated by W. G. Nagel, D. Fox, B. F. Gill, and others.

GRAHAM, VA.—The Graham Telephone Company is building a line to Stowersville, which will connect with the Clear Fork Company's lines.

PETERSBURG, VA.—It is rumored that a new telephone company is being projected. This, if successful, will be the third system in this town.

COLLIERSVILLE, VA.—The charter of the Rockbridge Telephone Company, of Colliersville, has been filed with the Secretary of State. The capital will be $5,000.

RICHMOND, VA.—The Bell Company, having completed its new system in Richmond, will require all subscribers to sign a new contract by October 1, which will increase rates. The city will investigate the proposed increase.

RICHMOND, VA.—The Fluvanna Telephone Company of Virginia is building a line between Whitehall and Wingina. The line will be extended to Bremo Bluff according to present plans. At the latter place a long distance connection will be made.

PARKERSBURG, W. VA.—Five hundred citizens attended a recent mass meeting to protest against the increase of rates by the Bell Telephone Company here. Those present agreed to discontinue the Bell service and subscribe for that of the West Virginia Western Telephone Company, the independent company. A committee was appointed to secure subscriptions to a bond issue to enable the independent company to place its system in first-class shape.

ANTIGO, WIS.—The Wisconsin Telephone Company is constructing lines from Wausau to this place.

ELECTRIC LIGHT AND POWER.

LOS ANGELES, CALIF.—The Etiwanda Power Company's capital stock has been subscribed in part by Geo. Chaffee, N. W. Stowell, J. W. Swannick, R. Harris and A. M. Chaffey, all of Los Angeles. The capitalization is $250,000.

SAN FRANCISCO, CALIF.—The Edison Electric Company, the Los Angeles corporation, which has commenced the hydraulic work on its 15,000-kw electric transmission system on the Kern River, recently closed a contract with the General Electric Company for a temporary generating plant. There will be two 150-kw 60-cycle 2300-volt generators and three 75-hp induction motors. These will operate the air compressors which will supply pressure for the air drills used to bore the big water tunnel that will require nearly a year in construction. It will take two years to complete the plant.

SOUTH MANCHESTER, CONN.—The electric plant which Cheney Bros., silk manufacturers, have erected on the Hockanum River is completed and electricity generated by water power is transmitted to the mills two miles away. The enterprise has involved $200,000. Electric power will be used both for operating purposes and lighting.

GEORGETOWN, DEL.—The Sussex Light, Heat and Power Company, of Georgetown, has been incorporated; capital, $25,000.

ROME, GA.—The town of Rome proposes to establish a municipal electric lighting plant and the city attorney has been requested to prepare a bill to be presented to the next legislature authorizing the issuance of $15,000 bonds for the same.

ALTON, ILL.—A communication has been received by the Alton city council from a Chicago company offering to establish in Alton for $35,000 an electric lighting plant of sufficient size to meet the present and the future needs of Alton. The city is now lighted by the Alton Railway, Gas and Electric Company, which has no opposition.

GOSHEN, IND.—The city council has granted a fifty-year franchise to the Hawkes Electric Company to operate an electric light plant in Goshen. This movement puts the private concern in a position of advantage over the plant owned by the municipality and may mean the absorption of the city plant by the Hawkes concern, as it is not on a paying basis and has always been the subject of political discussion.

RICHMOND, IND.—The electric light commissioners for this city, in charge of the municipal plant, have surprised the citizens by notifying the city that it will be charged for service the same as private consumers—the rate being $75 a year for each arc light. The commissioners say that if the plant is to be placed on a money-making basis at the start the city should assume the attitude of a private patron toward it.

SOMERSET, KY.—The village council has closed a contract for the erection of a $10,000 municipal lighting plant. Fifty arc lamps will be provided.

PRINCESS ANNE, MD.—The Princess Anne and Deal's Island Light, Power and Railway Company will build a railway line to Deal's Island with lateral branches. An organization was perfected on Sept. 2. H. P. Dashiell being elected president and O. T. Beauchamp, treasurer. As soon as the capital stock is subscribed the road will be built.

BUCHANAN, MICH.—There will soon be completed at this point one of the most notable electrical transmission plants in the middle west, one in which upward of $500,000 has been invested and from which many Indiana industries are expected to draw their power. The power will be furnished by ten turbine water wheels. Each wheel will furnish 300-hp. The wheels will be operated by the water of the St. Joseph river. The power house is 270 feet long, 30 feet wide and 30 feet high, the superstructure being of brick.

SCRANTON, MISS.—An offer of $25,000 has been made to the town of Scranton for the electric light and water plant. The offer comes from a northern capitalist who is also projecting an electric railway between Pascagoula and Moss Point.

NATCHEZ, MISS.—Negotiations for purchasing the Natchez Gaslight Company's plant have been on for some weeks, the object being a combination of electric light and street railway plants in the city. The Light, Power & Transit Company has recently sold out to the Electric Street Railway and Power Company for $75,000.

CASTILE, N. Y.—At a recent special election it was voted to build a municipal electric light plant to cost $10,500.

BUFFALO, N. Y.—The Fillmore Electric Light & Power Company, of Fillmore, has been organized. It has purchased the control of the waterfall in the Wiscoy Creek, which will be developed for the purpose of running the electric plant. It is estimated that 450 horse power will be available.

COLUMBUS, OHIO.—The Ada Water, Heat and Light Company has increased its capital stock from $25,000 to $75,000.

CONNEAUT, OHIO.—The municipal lighting plant has started the new equipment recently installed, consisting of a 360-hp Erie City engine, and a 4500-light Warren generator. New boilers are to be installed.

COLUMBUS, OHIO.—The East Columbus Heating & Lighting Company, which has recently secured a franchise to operate in the east end of the city, has secured a site for its power station and will commence work at once.

HUDSON, OHIO.—Messrs. Goeppinger & Backman, of Youngstown, have secured a 25-year franchise to operate an electric light plant in Hudson. There is a provision that the town may purchase the plant at the end of ten years.

TOLEDO, OHIO.—The Toledo Heating & Lighting Company is making extensive improvements to its system and is installing a large generator, a 400-hp Ball and Wood cross-compound engine and Green Engineering Company's chain-grate mechanical stokers.

GALLIPOLIS, OHIO.—The Gallipolis Electric Light Company offers to supply the town of Gallipolis with 70 arc lamps at the rate of $50 per lamp per year. The council is inclined to give the contract to Maxon & Eyesenbach, who ask $64 per lamp. The first-mentioned company is appealing to the citizens to secure the contract.

CLEVELAND, OHIO.—Prof. C. H. Benjamin, the city smoke inspector, is endeavoring to induce the city group-plan commission to build one central power station to furnish light, heat and power to the group of public buildings to be erected in Cleveland. The plan would effect a great saving and would decrease the amount of smoke in the vicinity.

KUTZTOWN, PA.—The Kutztown electric light company has increased its capital stock from $15,000 to $50,000, and will make many improvements.

ALLENTOWN, PA.—The United Waterpower Improvement Company has been incorporated to utilize the water power obtained from the several waterfalls in lower Pike County for the generation of electricity. The headquarters of the company are in the Betz Building, Philadelphia. The officers are J. P. Logan, president and treasurer, and C. J. Young, secretary and general manager. It is stated that 20,000 horse power will be utilized for the lighting and supply of power to the surrounding country.

ST. MATTHEWS, S. C.—Dr. L. M. Able is installing an electric plant for lighting stores; eventually, it is said, the town will be lighted by electricity.

NASHVILLE, TENN.—The new electric light plant of the city has been successfully tested. Four hundred and fifty arc lights are in use.

MEMPHIS, TENN.—The lighting committee of the city council has agreed upon a plan permitting a merger of the Memphis Light and Power Company and the Equitable Gaslight Company.

SALT LAKE CITY, UTAH.—The Rankins Electric Milling Company at Pollock, Ore., is installing a hydro-electric plant for the operation of its mills and lighting its plant. Mr. H. D. Rankins, of Pittsburg, president of the company, it is stated has invented a new electrochemical treatment for gold ores, which will recover all of the metal from low grade ore.

ST. ALBANS, VT.—Articles of association for the Vermont Light, Heat and Power Company have been filed. The company is capitalized at $200,000, and among the capitalists identified with it are J. J. Flynn and A. O. Humphrey, of Burlington, and E. Carpenter, of Worcester, Mass. The principal offices of the company will be in St. Albans.

NORFOLK, VA.—The electric power plants of Portsmouth, Va., will be consolidated by the new management, the Williams Syndicate, and a big power house will be erected.

NORFOLK, VA.—R. B. Fentress has again applied for a franchise to put in a heat, light and power plant. Mr. Fentress delayed pushing his application until the new constitution of the State was adopted.

WILLIAMSBURG, VA.—William and Mary's College will install an electric light plant, $5,000 having been appropriated for this purpose by the legislature. Dr. John W. Dawson is chairman of the board of visitors.

NORFOLK, VA.—The steamer "Atlanta," built by W. E. Cole, for catching fish by electric light, has proven a complete failure. The cost of the boat was $10,000. The plan was to attract fish by powerful electric lights and then scoop them in.

BALLARD, WASH.—At its last meeting the city council passed a resolution declaring in favor of building a new $25,000 electric light plant. The clerk was instructed to advertise for bids.

THE ELECTRIC RAILWAY.

SALEM, ARK.—Articles of incorporation have been filed by the Salem and Eastern Electric Railway. R. A. Youngblood is president and Sheriff H. F. Northcutt, secretary.

SAN JOSE, CALIF.—The San Jose and Santa Clara street railway and the Alum Rock railway, once separate corporations, but for the past two years owned and controlled by George and Hugh Center, have been purchased by the Standard Electric Company of San Francisco, which company, a few mnoths ago, purchased the two gas and electric companies of this city, and is now operating them under the title of the United Gas and Electric Company.

FT. WAYNE, IND.—The Ft. Wayne & Northern Electric Railway Company has incorporated for the purpose of constructing and operating an electric road between Ft. Wayne, Garrett, Auburn, Waterloo and Kendallville, and electric light plants in towns along the line. The capital stock of $10,000 will be increased. Beeks Erick, H. A. Randall and C. M. Neizer constitute the directors.

NEW CASTLE, IND.—Senator A. D. Ogborn, who holds a franchise for an electric railway from this city to Dunreith, announces that the road will be financed by St. Louis capitalists and the line built and put in operation by the first of the year. The line will connect with the Indianapolis, Greenfield and Richmond line at Dunreith, thus affording direct trolley connection with Indianapolis and Richmond.

COLUMBUS, IND.—An electric railway is projected to connect Indianapolis with Louisville by way of this city. The County Commissioners have granted franchises to Morton Hall and others. The various persons interested will meet in Seymour to organize a company. The road will connect with the Indianapolis and Greenwood line at Columbus, making a line from Indianapolis to Louisville, a distance of 163 miles. Louisville capitalists are backing the enterprise.

NEW IBERIA, LA.—The city council of New Iberia, La., has granted two franchises for electric railways—one to Hon. F. F. Myles, of New Orleans, and another to Hon. John A. McIlhenny.

FREDERICK, MD.—The Maryland Construction Company, which it is understood will build the Baltimore and Frederick trolley line, has received permission to build its tracks in the latter town.

MT. VERNON, OHIO.—Dr. J. F. Shrontz and J. W. Baird, of Martinsburg, Ohio, have applied to the county commissioners for a franchise for a line to extend from Mt. Vernon to Newark, by way of Martinsburg

MEDINA, OHIO.—Engineers of the Pomeroy-Mandelbaum syndicate are laying out the route for the extension of the Cleveland & Southern Railway from Medina to Wooster by way of Creston and Seville.

CLEVELAND, OHIO.—As the result of the new through Cleveland-Toledo service of the Lake Shore Electric Railway, the Nickel Plate (steam) has abandoned two of its suburban trains to Lorain and Vermillion.

MANSFIELD, OHIO.—The County Commissioners will probably grant a franchise to the Mansfield, Mt. Gilead & Delaware Electric Railway. W. W. Stark, C. E. Fitzinger and C. W. Fritz are at the head of the project.

SANDUSKY, OHIO.—President Parker, of the Sandusky, Clyde, Tiffin & Southern Railway Company, announces that arrangements have been completed with Eastern parties to finance the road and that construction work will soon start.

CONNEAUT, OHIO.—The county commissioners have granted the Conneaut & Eastern Traction Company a franchise from the State line to Conneaut. The road will run to Erie, Pa., as a part of the great system building along Lake Erie.

AKRON, OHIO.—The Akron-Alliance Connecting Railway Company has, it is stated, secured all the right of way, and work of construction will start in the near future. The power house will be located at Suffield. Freight trains are to be hauled by electric locomotives.

CLEVELAND, OHIO.—The Birmingham bridge on the Oberlin-Norwalk extension of the Cleveland, Elyria & Western Railway, has been completed and cars are now operated from Clevel and to Norwalk without change. At present the through cars are operated on a two-hour headway.

AKRON, OHIO.—The Northern Ohio Traction Company has placed an order with the Westinghouse Electric & Manufacturing Company for twenty sets of equipment for new cars which are to be built. In all, the company will purchase fifty cars, the majority of them for Akron city service.

FREMONT, OHIO.—The Lake Shore Electric Railway Company is planning to abandon the old Sandusky, Norwalk & Southern power station at Milan, and will build a combined sub-station, freight and passenger station at Milan to take care of that division of the system, current being furnished from the Fremont power house. A sub-station is also to be erected as Vermillion.

CINCINNATI, OHIO.—The Cincinnati Interurban Company has been incorporated with $100,000 capital stock by W. K. Schoepf, G. H. Warrington, W. H. MacAlister, S. C. Cooper and F. B. Spangler. The company will operate the consolidated line formed by the Millcreek Valley Railway Company and the Hamilton, Glendale & Cincinnati Traction Company, which have been leased to the parties mentioned.

CANTON, OHIO.—The Canton & New Philadelphia Railway Company has elected officers as follows: Philip Saltonstall, Boston, president; L. E. Myers, Chicago, vice-president and general manager; Chauncy Eldridge, Boston, secretary-treasurer. The above, with J. Reeves, Canal Dover; E. C. Lewis, Canal Dover; J. C. Welty and G. W. Rounds, of Canton, are directors. This is the company which is building a southern extension of the Canton-Akron Railway.

TOLEDO, OHIO.—The Toledo, Columbus, Springfield & Cincinnati Traction Company has elected officers as follows: Ellis Bartholomew, president and manager; S. M. Finch, 1st vice-president; J. H. Forrest, 2nd vice-president; I. N. Covault, secretary; Wm. P. Heston, treasurer. The above, with T. F. Whittlesey, S. S. Thorn, S. C. Heston and E. C. Schinness, are directors. A portion of the road is already under construction and arrangements have been completed to commence work on an additional 40 miles.

SPARTANBURG, S. C.—Northern capitalists have investigated a project for a 30-mile trolley line to Greenville, and it is said that a charter will soon be applied for. It is proposed to develop several fine water powers along the route.

HARRIMAN, TENN.—A scheme is being agitated contemplating an organization of Roane County capitalists to build an electric railway to Rockwood and Kingston, also to Knoxville by way of several intermediate points.

NASHVILLE, TENN.—A new electric and steam railway to McMinnville will be built, it is said, to be under the management of W. S. McKittrick, a Chicago railroad contractor. The cost will be over $750,000. The road will be 73 miles long and will pass through several prominent towns en route to McMinnville. Northern capital will operate the line, a survey for which has already been completed.

AUSTIN, TEX.—Important extensions of the street railway system of the Austin Electric Street Railway Company are being made. One of these extensions is to run from the union station to the State blind asylum, through a residence part of the city which is now without street railway transportation facilities. Several handsome new cars have also been ordered for use on this system.

SALT LAKE CITY, UTAH.—It is stated that American capital is interested in a group of mines in the West Kootenay country, British Columbia, and proposes to construct an electric railway from the mouth of the Duncan River several miles up its course, with side lines connecting with mining camps.

WHATCOM, WASH.—The commissioners of Whatcom County, Wash., have granted a franchise for an electric railway between Whatcom and Lynden to C. A. Wiatt, G. H. Butters and C. L. Likins.

CITY OF MEXICO, MEX.—The work of constructing several important extensions of the Federal District Street Railway Company's lines in the City of Mexico is delayed on account of the failure to receive the rails promptly from the American manufacturers. Thirty new cars have been ordered for use on these lines.

TAMPICO, MEX.—The construction of the new street railway system in the city of Tampico, is now in progress. A. P. Breton, an American, is at the head of the enterprise. At first the system will be operated by mule power, but the terms of the concession granted to Mr. Breton specifies that it is to be converted into an electric system within two years after construction is completed. The road is planned to run from the wharves of the port, through the principal streets of the city and to the fashionable seaside suburban resort of Dona Cecila, and thence to the beach, four miles from the city. The road will be ten miles long.

THE AUTOMOBILE.

AUTOMOBILE ENDURANCE TEST.—Some thirty automobiles are already entered for the 500-mile reliability contest, New York to Boston, of the Automobile Club of America. All are gasoline or steam. Mr. A. L. Riker has entered one gasoline made by the Locomobile Company of America, of his design, and the Ward-Leonard Electric Company has two gasolines.

NEW INDUSTRIAL COMPANIES.

THE LA BOITEAUX COMPRESSED AIR ELECTRICAL COMPANY, of Cincinnati, Ohio, has been incorporated with a capital of $100,000.

THE SPARTANBURG ELECTRICAL MACHINERY COMPANY, of Spartanburg, S. C., has applied for a charter. Its capital stock is $8,000.

THE BOSTON ELECTRIC FAN AND HEATING COMPANY, of New York City, has been incorporated at Dover, Del., with an authorized capital of $225,000.

THE MODERN ELECTRIC COMPANY has been incorporated at Camden, N. J., with a capital stock of $300,000, by Jas. W. Forster, Samuel Forster and A. A. Rolf.

THE REVERSIBLE ELECTRIC CAR-SIGN COMPANY has been chartered at Richmond, Va., to manufacture electric signs and other specialties. Mr. W. M. Glazebrook is president.

THE NEW YORK ELECTRIC HEADLIGHT AND TRAIN LIGHTING COMPANY, of Yonkers, N. Y., has been incorporated at Albany, with a capital stock of $1,000. The directors are H. D. Crippen and W. J. Huston, of New York City, and F. A. Curtiss, of Nutley, N. J.

THE NATIONAL TELEGRAPH NEWS COMPANY, has been incorporated at Hillsboro, Ill., the capital stock being $150,000. The incorporators and directors are L. M. Martin, A. K. Bromn, F. E. Crawford, A. T. Stewart and W. R. Stewart, Jr. The principal office is to be located at Chicago.

LEGAL.

A BRAKE ORDINANCE.—At Detroit, on Sept. 13, Judge Phelan handed down a decision upholding the city ordinance requiring the street railway company to operate its cars with electric or air brakes. He found the street railway company guilty of violating the ordinance and imposed a fine of $50. The case will be appealed by the company to the State Supreme Court, and perhaps to the United States Supreme Court. In his decision Judge Phelan says: "The point was made, and is still insisted upon by the respondent, that this ordinance is *ultra vires,* and beyond the corporate power of the City of Detroit to enact as municipal legislation, and this may be true, unless this municipal legislation can be supported as a just exercise of police power to protect the lives and limbs of its citizens and sojourners within limits from undue risk. If this ordinance has a tendency to preserve life and limb and avoid deplorable accidents in any considerable degree, it is my duty to sustain it. I believe this will be the effect."

PERSONAL.

MR. C. P. PLATT, of the sales department of the Kellogg Switchboard & Supply Company, of Chicago, is confined to his house with typhoid fever. His many friends hope for a rapid recovery.

MR. HARRY DE STEESE, formerly of the Western Electrical Company, has become connected with the Stuart-Howland Company, of Boston, and will have charge of its New York office, a position for which his familiarity with the electric railway field gives him special qualifications.

MR. J. R. WHARTON, manager of Butte, Montana, Electric Railway, had charge of the exhibition in connection with the recent meeting at Butte of the International Mining Congress. The success of this feature was so great that the exhibition will be kept permanently in that place, though it may be shown at the St. Louis Fair.

EDUCATIONAL.

THE ASSOCIATION OF ELECTRICAL AND MECHANICAL ENGINEERS has been formed out of the members of the senior class of the University of California college of mechanics. Bi-weekly meetings will be held, and at intervals, tours of inspection through electrical and mechanical plants will be made. The officers of the organization are Robert Sibley, president; A. J. Turner, vice-president; H. Philips, Secretary; C. C. Murray, treasurer.

Trade Notes.

THE YOUNGSTOWN MANUFACTURING COMPANY, Youngstown, Ohio, is working up a very large business in the manufacture of electric cranes.

THE GOLTZ ENGINEERING COMPANY, Chicago, makes a specialty of manufacturing metal block letters for electric signs. Its new bulletin No. 3, just published, should be in the hands of firms installing electric signs.

THE COLONIAL ELECTRIC COMPANY, Ravenna, Ohio, has elected directors as follows: T. H. Gillmer, E. W. Gillmer, E. E. Nash, E. E. Roberts and W. C. Ward, of Warren; W. C. Gans, of Youngstown, and J. B. Estabrook, of Ravenna.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is advising the trade to anticipate their requirements in the matter of Butmann wattmeters. The growing popularity of this meter is bringing a rush of orders that is bound to tax the capacity of the factory.

THE GARVIN MACHINE COMPANY, New York, has just issued a catalogue (No. 12) descriptive and illustrative of its line of duplex drill lathes, hand lathes, slide rests and spring coilers. The dimensions of the different machines are given in tabular form.

NORTHERN MULTIPOLAR MOTORS.—The Northern Electrical Manufacturing Company, Madison, Wis., in its bulletin No. 29, very fully describes and illustrates the construction of its line of power motors. Illustrations show the details of the machine very clearly.

THE STEAM & ELECTRICAL EQUIPMENT COMPANY, Pittsburg, has recently sold a 190-kw Stanley 60-cycle, 2200-volt two-phase alternator to the Poughkeepsie Light, Heat & Power Company, and a 108-hp Babcock & Wilcox boiler to the Waynesburgh Electric Light & Power Company.

INJECTORS.—Metropolitan injectors constitute the subject of a 48-page pamphlet just issued by the Hayden & Derby Manufacturing Company, 85 Liberty Street, New York. The pamphlet is artistically illustrated and gives much specific and general information on the subject of injectors.

COPPER PRODUCTS.—The Eureka Tempered Copper Company, North East, Pa., has just issued a 48-page catalogue and price-list of its copper and brass products for all purposes. The illustrations include commutator segments, street railway commutators, Brush segments, brushes, and a line of switches.

"INDUSTRIAL RAILWAYS FOR SHOP TRANSPORTATION," is the title of a pamphlet recently brought out by the C. W. Hunt Company, West New Brighton, Staten Island, N. Y. Six of the eight pages are entirely taken up by illustrations of installations of this class. The advantages possessed by the Hunt system of "Industrial" railways are briefly pointed out.

THE LINK-BELT ENGINEERING COMPANY, Nicetown, Philadelphia, Pa., has issued a pamphlet illustrating and describing a few special applications of its machinery in railway and steamship work. The illustrations show locomotive coaling stations and ash-handling plants in practical operation in various parts of the country, and actual installations of freight carriers for loading and unloading vessels.

SCALE IN BOILERS.—The Harrison Safety Boiler Works have issued a pamphlet entitled, "That no Scale Shall Form in Boilers," and devoted to an account of the Sorge-Cochrane system of feedwater heaters and purifiers. The principle of this system is to heat the feed water almost to the boiling point, and by a simple mechanical and chemical treatment remove the scale-forming constituents and neutralize any free acid present.

VICTOR INSULATORS.—Mr. Fred. M. Locke, Victor, N. Y., has just issued a very artistic catalogue containing illustrations of his extensive line of high-tension insulators and accessories. Besides insulators, there are several views of high-tension lines in California for the insulation of which Victor insulators are used. Accompanying the illustrations of the insulators are given the dimensions, and at the back is given a list of plants using Locke insulators and pins.

BULLOCK BULLETINS.—Bulletins 1002, 1003 and 1012 of the Bullock Electric Manufacturing Company, have for their respective subjects, Bullock type "N" motors; marine lighting and power sets and direct-current multipolar motors. Each of the bulletins is profusely illustrated, the apparatus being shown in complete detail, not only by photographic reproductions, but also by line drawings. In the first-mentioned bulletin a large number of machine tools are shown fitted with Bullock motors.

BRAZING IRON.—The American Brazing Company has absorbed the American Ferrofix Company, together with its American rights, for a process recently brought out in Germany for brazing iron. It is claimed that by this process iron may be brazed so that a mended joint is stronger than an unbroken section of the same area. It is also claimed that the process can be used for mending broken castings. The company announces that its plans are to reach directly every responsible blacksmith in the country.

MANVILLE FIRE EXTINGUISHER.—The H. W. Johns-Manville Company, New York, has added another and valuable article to its long list of products, in the form of a fire-extinguishing powder. The powder is enclosed in decorated tubes which may be hung in convenient places in the house, office, factory or warehouse, and is always ready for immediate use. It is stated to be non-poisonous, will not freeze, cake in the tubes, is not affected by dampness and will not deteriorate with age. A neat booklet, just issued by the company, tells all about this interesting product.

THE READING GAS & ELECTRIC FIXTURE CO., Reading, Pa., has appointed the Carleton-Chase Electric Co., Havemeyer Building, New York, selling agent for its line of electrical apparatus including knife switches, panel, switch and tablet boards and electric, combination and gas fixtures. Owing to its recent consolidation with the National Brass & Iron Works, the Reading Gas & Electric Fixture Co. is in possession of greatly increased manufacturing facilities and can guarantee not only first-class work, but what is of almost equal importance—prompt shipments.

WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, general selling agents for A-B arc lamps, reports that the demand is increasing steadily, and that it anticipates an unusually heavy Fall business. It states that it now has over 100,000 of these lamps in general use, and that it is being rapidly adopted by most of the larger cities. This is one of the oldest arc lamps on the market, and as the A-B Company has devoted its exclusive attention to the manufacture of arc lamps, it has lost no opportunity to improve them in every way. These lamps are made with weatherproof, solid copper or pressed steel cases, and for all circuits. The company issues a number of bulletins describing these lamps fully, which are mailed on application.

LUNKENHEIMER CATALOGUE.—The extent of the business of the Lunkenheimer Company may be appreciated from a perusal of its latest catalogue which contains 208 pages of description and illustrations of its complete and extensive line of steam specialties. The variety of the brass and iron steam specialties produced by this company, as shown by this catalogue, is quite surprising, and with one or two exceptions all of the goods listed are entirely manufactured by the company. The company expects to occupy its new factory buildings by the end of this year. These buildings, it is stated, will be unsurpassed by any similar structures of their kind. Every steam engineer will be interested in this catalogue, a copy of which will be sent free on application.

INCANDESCENT LAMPS.—The Sawyer-Man Electric Company, New York, has issued a handsome pamphlet giving a historical sketch of the incandescent lamp, and a very clear description of the process of manufacturing the Sawyer-Man lamp. The manufacture of this lamp was the subject of an illustrated article in ELECTRICAL WORLD AND ENGINEER of Aug. 16, last. The pamphlet is very artistically and profusely illustrated with views of historical lamps and shows applications of incandescent lamps for illumination and decoration, some notable buildings and establishments being included. The illustrations of the various steps in the manufacture of the Sawyer-Man lamp are especially interesting and the descriptive matter gives much information that is not generally known concerning this industry. The booklet will likely become a very desirable addition to electrical libraries for reference on account of the information it contains.

Record of Electrical Patents.

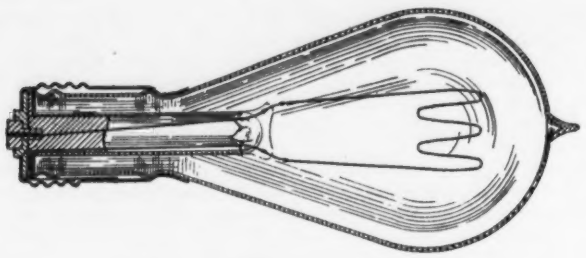
UNITED STATES PATENTS ISSUED SEPTEMBER 9, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

708,539. VIBRATORY CURRENT RELAY; J. M. Fell, Arlington, N. J. App. filed Sept. 16, 1901. (See page 458.)

708,559. TROLLEY POLE; C. D. Jenney, Indianapolis, Ind. App. filed Dec. 8, 1900. A portion of the length of the pole is composed of a spiral spring, the lower end of which is seated at the bottom of a bowl-like socket which supports the spring regardless of the direction in which it turns.

708,599. TRAP FOR AMALGAM; G. R. Tuttle, Grass Valley, Cal. App. filed Aug. 7, 1901. A trap in which to catch the amalgam flowing in stamp-mills, consisting of cells inserted in the path of movement of the amalgam, the



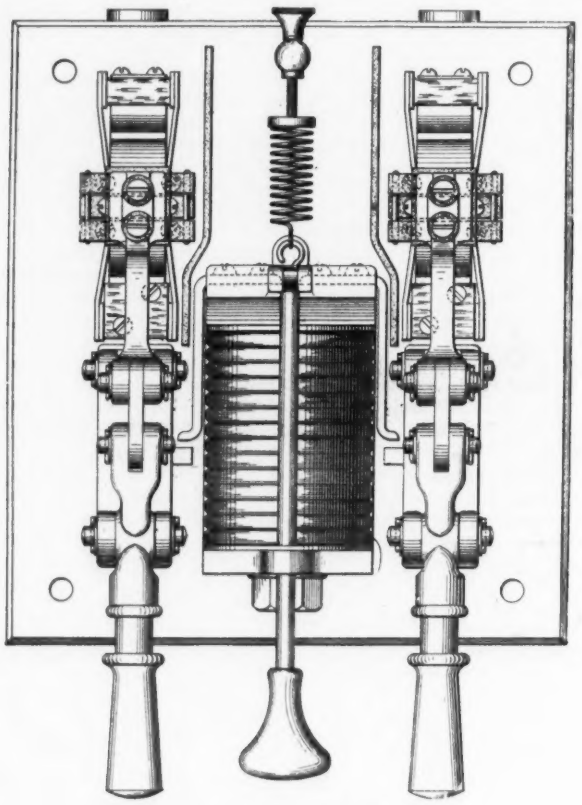
708,653.—Incandescent Electric Lamp.

cells being composed of two kinds of metals, whereby a current is established and the amalgam attracted to the cells.

708,653. INCANDESCENT ELECTRIC LAMP; A. W. W. Miller, South Orange, N. J. App. filed Oct. 17, 1901. A lamp which may be readily opened at the neck for cleaning and inserting a new filament, reclosed, exhausted and sealed.

708,656. ELECTRIC RAILWAY; T. E. Murray and J. Van Vleck, New York, N. Y. App. filed Feb. 26, 1902. (See page 461.)

708,664. COMMUTATOR BRUSH HOLDER; W. J. Richards, Milwaukee, Wis. App. filed Jan. 20, 1902. Details.



708,710.—Circuit Breaker.

708,671. ANTISEPTIC ATTACHMENT FOR TELEPHONE MOUTHPIECES; H. C. Smith and M. H. Woolsey, San Francisco, Calif. App. filed Feb. 24, 1902. (See page 458.)

708,692. JUNCTION BOX; W. F. Bossert, Utica, N. Y. App. filed June 4. 1902. Reinforcing pieces are fixed to the corners of the boxes and serve as supporting feet therefor.

708,694. A METHOD OF MANUFACTURING SECONDARY BATTERY PLATES; Geo. H. Christian, Cleveland, Ohio. App. filed Dec. 7, 1901. In the formation of lead plates the peroxide is reduced in an electrolyte containing a compound of an organic reducing agent and an alkaline earth, such as exalate of potassium, sodium, etc.

708,695. METHOD OF MANUFACTURING PLATES FOR SECONDARY BATTERIES; Geo. H. Christian, Cleveland, Ohio. App. filed Dec. 7, 1901. The above patent with a different phraseology of claims.

708,708. ELECTRODE SEPARATOR FOR BATTERIES; Arthur W. Harrison, Los Angeles, Calif. App. filed May 7, 1902. A plate separator made from the tree yucca from which the fine fibrous material has been extracted without destroying the fibre, by boiling in sulphuric acid or caustic soda.

708,710. CIRCUIT BREAKER; E. M. Hewlett, Schenectady, N. Y. App. filed Sept. 29, 1898. Two independent switches operated simultaneously by a tripping coil.

708,724. OPERATING MECHANISM FOR MOTOR CONTROLLERS; F. A. Merrick and J. D. Forrer, Johnstown, Pa. App. filed Feb. 12, 1901. A mechanical relation of the reverse and regulating switch-handle, whereby it becomes inconvenient for the motorman to operate the reverse switch unless the regulating switch is at its off position. Although subject to such inconvenience the reverse switch may be operated at any time and in all positions of the regulating switch.

708,755. ELEVATOR; M. A. Chennam, San Francisco, Cal. App. filed Jan. 26, 1901. A system in which the car can be started in either direction and stopped at a particular landing by a person located on any floor.

708,796. BLEACHING APPARATUS; Chauncey Cook Clark, Philadelphia, Pa. App. filed Jan. 22, 1901. The separation of chlorine gas from common salt is produced by a series of electrodes suspended in the salt solution, the residium falling to the bottom of the receptacle where means are provided for its removal. The heat forming during electrolysis is absorbed by a series of tubes in the solution, through which cold water is circulated.

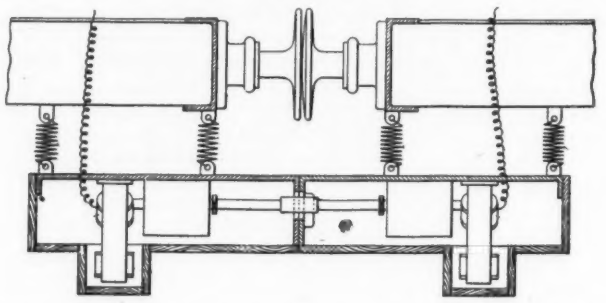
708,803. DYNAMO AND MAGNETO-ELECTRIC MACHINE; N. H. Edgerton, Philadelphia, Pa. App. filed Aug. 22, 1901. Details of construction.

708,875. DYNAMO AND MAGNETO-ELECTRIC MACHINE; N. H. Edgerton, Philadelphia, Pa. App. filed May 23, 1902. The combination with segregated fields of soft iron, energized by currents flowing through the armature circuit only, of an annular inclosing frame of diamagnetic material, and an armature within said magnets having its windings parallel with its shaft, and at right angle to the laminated field.

708,921. PROCESS OF MANUFACTURING CALCIUM CARBIDE; I. L. Roberts, New York, N. Y. App. filed March 18, 1897. (See page 458.)

708,927. DEVICE FOR CONNECTING THE ELECTRICAL GEAR OF ELECTRIC CARS; A. Siemens, Westover, Milford-On-Sea, England. App. filed March 24, 1902. To mechanically connect the shaft of a controller on one car with that on another, the controllers are mounted in swinging boxes below the car coupling and their shafts rigidly connected. This permits motion of the controllers independent of the cars.

708,960. METHOD OF CONTROLLING ELECTRIC MOTORS; J. C. Henry, Denver, Colo. App. filed June 3, 1899. A method of starting a pair of motors consisting of first placing them in parallel in opposite rela-



708,927.—Device for Connecting the Electrical Gear of Electric Cars.

tion to each other, each armature being in series with the corresponding field and cross-connecting them so that each armature is in shunt with the field of the other motor.

708,961. METHOD OF CONTROLLING ELECTRIC MOTORS; J. C. Henry, Denver, Colo. App. filed April 1, 1901. The method of controlling a plurality of electric motors, whose fields are excited by a circuit independent of the armature, which consists in starting with the armatures in series and the fields in parallel and speeding up by changing the fields to series without breaking their circuit.

708,962. ELECTRIC VEHICLE. S. A. Henry, Denver, Colo. App. filed June 3, 1899. The motors are employed to operate and stop a vehicle to regenerate to the battery in the form of electricity the energy ordinarily destroyed by the application of frictional brakes where they are used to overcome the force of momentum or gravity.

708,969. ELECTRIC RAILWAY; T. E. Murray and J. Van Vleck, New York, N. Y. App. filed March 14, 1902. (See page 461.)

The Electrochemical Meeting at Niagara Falls.

THE second general meeting of the American Electrochemical Society, held at Niagara, during the present week, scores another marked success for this body. Up to Tuesday evening, 150 members and guests were registered, and at the meeting on Tuesday about 110 members were present, or more than 25 per cent. of the entire membership—a remarkable record it is, perhaps, needless to add. As at Philadelphia, there is an enthusiastic interest shown in the Society and its objects, an evidence of which is the large attendance at the sessions and the liveliness of the discussions.

The only untoward incident was the refusal of the managers of the Niagara electrochemical works to allow those in attendance at the meeting to visit the plants, in which, however, five did not join—namely, the Carborundum Company, International Acheson Graphite Company, Electrical Lead Reduction Company, and Atmospheric Products Company.

The local committee had made arrangements for the entertainment of the ladies of the party, and laid out for each afternoon and evening an excellent programme, including visits to all points of scenic interest. As usual, when acting as host for conventions, the International Hotel provides a concert or other parlor entertainment on evenings when an attraction is not provided elsewhere.

Following is an account of the proceedings of Monday and Tuesday: Mr. Francis A. J. Fitzgerald presented the first paper of the meeting, the title being "Notes on Testing Carbon Electrodes." It was pointed out that the efficiency of an electrode depends largely on its density, and the paper deals with methods for the determination of density. Two determinations are made—first, of the density of the carbon of which the electrode is made, and, second, the apparent density or the ratio of the weight to the volume of the electrode as a whole. The difference of these quantities divided by the first-mentioned expresses the porosity. The paper gives the methods of determination in minute detail. In the case of a specimen, the real density was found to be 2.19, the apparent density 1.63, and the porosity 0.26.

In certain electrolytic processes the presence in an electrode of amorphous carbon is undesirable, owing to the accompanying disintegration, and the paper describes a method of testing to determine if they are entirely composed of graphite.

Mr. Fitzgerald's paper was briefly discussed by Messrs. Hart, Hutton and Keith, their remarks referring more particularly to details of the test.

In a paper, entitled "Cathodic Reduction," Mr. Alfred T. Weightman gave the results of experiments with sulphide electrodes, which showed that Thomson's rule does not apply, at least when expressed in its simple form. The two divergences are with respect to the voltage of reduction and the amount of hydrogen released. It was shown that much less hydrogen is released than the rule calls for, and this fact is of advantage in commercial working. The higher voltage accords with the views of Caspari and others, that the voltage necessary to liberate hydrogen is not a constant, as implied by Thomson's rule, but is dependent on the metal which constitutes the cathode. Mr. Weightman adds that in addition there is probably also a variation in voltage for H_2S with different metals.

A lengthy discussion followed the reading of the paper, in which Messrs. Reid, Keith, Smith, Rodman, Haber, Smith, Blackmore, Hering, Hutton and Sperry participated. Mr. Reed did not consider Caspari's theory necessary to explain the results arrived at, but Prof. Haber and others took the opposite view—namely, that Caspari's theory of over-voltage was correct and applied to the experiments in question. In reply to a question by Mr. Hering as to the source of the energy corresponding to the over-voltage, Prof. Smith said it corresponds to the second term of Helmholtz's equation containing the temperature coefficient of the e. m. f. Prof. Haber said there may be intermediate steps between ions and gases, such as solution, absorption, the formation of an alloy, etc.

President J. W. Richards' paper, entitled "Efficiency of Electric Furnace Operations," discussed a large number of operations. From the data presented, it appears there is an unexpected uniformity in the efficiency of different processes where the heat is employed, not only in melting the material but also in chemical action. In this case the efficiency is generally 50 to 60 per cent. In processes where there is simply a heating action without chemical action, the efficiency is higher, approximating 70 to 75 per cent.

In the following discussion, Mr. Hering said that determination of the efficiency involves knowledge of the actual energy necessary to a given process, but that in many cases this is not exactly known; consequently until this theoretical quantity is fixed, efficiencies must be accepted with caution. In reply to a question by Mr. Brindley as to the reduction of radiation loss by double walls, Prof. Richards said that the important factor is whether the operation is conducted slowly or quickly.

The final paper of Monday's session was read by Prof. Louis Kahlenberg, the title being "Differences of Potential Between Metallic Sodium and Solutions of Cadmium Iodide in Various Solutions." The greatest potential difference was measured between cadmium and cadmium iodide in a large number of various solutions, the other electrode in each case being Helmholtz's normal electrode. The general result was that the potential difference between a metal and a solution is primarily determined by the chemical affinity. With solvents of similar chemical character there is little variation in the potential difference.

In the afternoon, under the guidance of the local committee, visits were made to the power house of the Niagara Power Company, the works of the Electrical Lead Reduction Company, the International Acheson Graphite Company, and the Carborundum Company.

The first paper of Tuesday's meeting was entitled "Developments in Electrometallurgy of Iron and Steel," and in the absence of the author, Mr. Marcus Ruthenberg, was read by Prof. Hart. A method outlined consists in principle in using an electric furnace combined with the action of a magnetic field. The melting zone of the electric furnace is a magnetic field. The ore being magnetic, the magnetic field seizes and holds the grains of the magnetite, and the polar projections being at the same time the electrodes of the smelting circuit, the magnetic bridge thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit is engendered within the bridge of ore itself. The electrodes are water-cooled. When the ore is melted it loses its magnetism and drops out of the magnetic zone, new material being substituted. An animated discussion followed, in which Messrs. Hart, Keith, Johnson, Reed, Richards and Salom took part. The general opinion seemed to be that there is at present no probability of the electric furnace superseding the blast furnace in the reduction of iron ores; that the ordinary iron smelting furnace of to-day is a very efficient piece of apparatus; and that magnetic concentration of ores is only of use in the case of low-grade ores.

In a paper by Dr. Eugene A. Byrnes, entitled "Voltaic Cells with Fused Electrolytes," the results are given of a great many measurements of the e. m. f. of cells, in which the electrolyte was fused sodium hydroxide. The cell was divided into two parts by a porous diaphragm. The one electrolyte was graphite, and for the other many various substances were used. Different depolarizers were used. The results of the measurements are in several points in good agreement with results obtained by Liebenow and Strasser. In the discussion, Mr. Reed claimed that the e. m. f. of such cells is nearly wholly thermoelectric, but this was contested by Mr. Byrnes, who said that the thermo e. m. f. is only a factor and not the principal one.

In a paper, entitled "The Fusion of Quartz in the Electric Furnace," Prof. R. S. Hutton, of Owens College, Manchester, described a process for making quartz fibres and small tubes for scientific pur-

poses. An arc furnace is used, and the quartz fused in a mould of graphite. At first there were difficulties, owing to air bubbles, but these have been overcome. Prof. Hutton considers there is a commercial future for the process. The paper was briefly discussed by Messrs. Whitney, Bancroft, Fitzgerald and Doremus.

In a paper, entitled "Thermoelectric Theory of Concentration Cells," Prof. H. S. Carhart extended his discussion of this subject, which was presented at the Philadelphia meeting. In Nernst's formula, the e. m. f. of a concentration cell is proportional to the absolute temperature, which suggests a thermal origin. The same conclusion is reached from Helmholtz's formula for the e. m. f. of a voltaic cell; for a concentration cell the first term of this formula is zero, corresponding to the formation heat of the chemical processes, and the e. m. f. is directly equal to the absolute e. m. f. multiplied by the temperature coefficient of the e. m. f. A concentration cell is a device for converting heat into electrical energy. Curves were exhibited, showing the relation between thermo e. m. f. and concentrations, and it was shown how the law of the inverse of the thermo e. m. f. with the concentration explains several obscurities relating to the Daniell cell.

The paper was discussed at length by Messrs. Bancroft, Haber, Hering, Carveth, Patterson, Weightman, Richards and Keith. Doubt was expressed whether the particular nickel cell is really a true concentration cell, and Prof. Carhart did not deny that there may be chemical action in it.

In a paper, entitled "An Apparent Electrochemical Paradox," Mr. Carl Hering described a curious experiment which he and Mr. Reed made some years ago, in which water was decomposed in visible quantities at voltages far below the theoretical (about 1.45), even as low as about 0.3 volt. The experiment consisted in electrolyzing acidulated water in a strong N-shaped glass tube, which was sealed at both ends, and provided with a bend containing mercury, which enabled the mechanical pressures to be read off. The results were shown in a curve. The pressures reached about 23 atmospheres when the tube exploded. The voltage at the terminals when a constant current passed diminished rapidly and very decidedly to about 0.3 volt, at about 16 atmospheres, and then remained practically constant. Allowing for the loss due to resistance, the actual voltage of decomposition was even much lower—nearly zero. There was visible gasing during the whole test, showing that water was really being decomposed; the increasing pressures also showed this. A possible explanation was suggested, based on the assumption that some of the gases probably passed mechanically to the opposite electrode, which they could easily do in suspension, as the electrodes were very close together. These were consumed as depolarizers, so that only a fraction of the theoretical amount of gas was really liberated. This depolarization lowered the voltage. A calculation based on this reduced amount of gas which was actually liberated, on the actual current which passed, and on the energy which must be accounted for to conform with theory, would also show that the required voltage need be only very low; the lower, the greater amount of depolarization. The paper concluded with a suggestion of an experiment in which water is electrolyzed in a strong, sealed vessel, which is completely filled so as to leave no room for the gases. Some curious results may then be expected. The paper was discussed by Messrs. Rodman, Johnson, Carhart, Reed, Hutton, Burgess, Bancroft, Haber, and Richards, most of whom accepted Mr. Hering's explanation. On Tuesday evening a number of members, by personal invitation, visited the works of the Atmospheric Products Company.

Convention of Fire Engineers.

The thirtieth annual convention of the International Association of Fire Engineers was held during the present week in New York City, at the Grand Central Palace, and was in full progress when this issue went to press. The attendance was very large, the regular exercises being supplemented by an admirable exhibit of fire apparatus, under the skillful management of the veteran entrepreneur, Mr. Marcus Nathan. Mayor Low welcomed the convention to the city. Among the papers read was one by Capt. W. Brophy, of Boston, dealing in an able and conservative manner with the subject of electrolysis, and discussing its effect on gas and water pipes and the remedies. Mr. J. W. Stover, president of the Gamewell Fire Alarm and Telegraph Company, was also on the programme for a paper, on the progress made of late years in fire alarm telegraphy. During the week, the New York Fire Alarm Telegraph Bureau was visited by the delegates, who were also given a ride around the upper part of the city in electric automobiles.